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Fuzzy Logic Control

M. Suganya[1], K. Jayanthi[2]
[1]Assistant Professor, St. Joseph's College for Women, Tirupur, Tamil Nadu, India
[2] St. Joseph's College for Women, Tirupur, Tamil Nadu, India

ABSTRACT

As it knows most of the quotidian types of control, problems are not simply to evaluate and considerate formal modelling based in traditional techniques. The process control makes the evaluation and executions more efficient in the industry. This article was made with the purpose to compare two types of control, one with FUZZY logic and second one PID control. Here we have developed temperature control system using fuzzy logic. The flyback converter with voltage doubler rectifier acts as an output module. To overcome the efficiency degradation during lightload due to load dependent soft switching of the ZVS, a control method using pulse width modulation (PWM)proportional to the load current is used. Comparison between Fuzzy logic controller & PID controller based on pulse width modulation is proposed and the results are analyzed. Thus comparing the result PID controller gives more accurate results than first Fuzzy logic controller.
Keywords : Pulse Width Modulation(PWM), Membership Function, Defuzzication, Fuzzication.

I. INTRODUCTION

This fuzzy logic was investigated in 1965 by Lotfy A. Zadeh. Engineer, in the Berkeley University (California). Associate a fuzzy set with a linguistic term is the easy way to understand the system behaviour. In the beginning, this kind of control the scientist population did not accept it but when Zadeh published more of his theories there was another scientist who contributed to the development of this theory. The Zadeh's goal was create an easier method to manipulate the imprecision the best way possible and associate with the human vague thought and their linguistic expressions. The PID control is the most conventional tool for control process; today the PID control is find it in all areas, and the design come in many different forms.

The PID control is important for the distributed control system. The structure of a PID controller is as simple as it's its weak point, that's because its range of control is limited. The goal of this project is compare what the fuzzy control can do against a PID, which it is a classical control. The comparisons are made with: error, stability, overshoot and response time.As a desirable solution to the above mentioned drawbacks this paper proposes DC-DC converts using active clamp technique and pulse width modulation control. It integrates a bidirectional boost convert with a series output module as a parallel input series output (PISO) configuration.This connection makes the bidirectional boost converter as up active clamp circuit. Therefore it uses the step up capability of the stacked output capacitors while maintaining the soft switching capability of the active clamp circuit.

However the proposed has a load-dependent ZVS condition, which is an inherit characteristic of the active clamp circuit. It causes hard switching at a light load and degrades conversion efficiency. To recover ZVS at a load, a control method using Pulse Width Modulation (PWM) is also proposed.

II. METHODS AND MATERIAL

2.1 FUZZY CONTROL

Low cost temperature control using fuzzy logic system block diagram shown in the fig. in this system set point of the temperature is given by the operator using 4X4 keypad. LM35 temperature sensor sense the current temperature. Analogue to digital converter convert analogue value into digital value and give to the Fuzzy controller.

Fig 2.1 : Fuzzy Control System

Controller calculates error between set point value and current value and consider as Input function of fuzzy logic. By fuzzification process controller calculate it membership. After in rule base and inference system output membership value calculated. Defuzzification process calculates actual value of PWM for heater and fan which is output of the temperature control system.

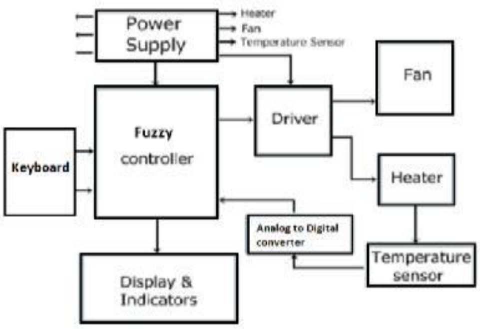

Fig 1 : Block diagram of temperature control system

The process comprises of a heater, fan and a temperature sensor. The amount of current passing through the coil decides the temperature of the thin metal plate. Temperature detection of this metal plate can be done by dedicated temperature sensors. A fan is placed near to the heating mechanism. Amount of power delivered to both heater and fan can be controlled by passing a command through serial port via microcontroller. Now, microcontroller generate PWM (Pulse Width Modulation) signal for the MOSFET to deliver desired amount of power to fan and heater. It could thus be used as a small plant readily available for various experimentation.

2.2 WORKING PRINCIPLE OF FUZZY CONTROL

Temperature control system shown in below figure is works on the basic principle of fuzzy logic. The fundamentals of fuzzy logic elaborated by LotfiA. Zedeh, a professor at the University of California at Berkle . He presented fuzzy logic not as a control methodology, but as a method of processing data by allowing partial set membership instead of non membership. Until 70's due to insufficient small computer capability the method of set theory was not applied to control system. Nonlinear mapping of an input data set to a scalar output data is known as fuzzy logic system. A fuzzy logic system consists of four main parts:

i) Fuzzifier
ii) Rules
iii) Inference engine
iv) Defuzzifier.

These components and the general architecture of a fuzzy logic system.

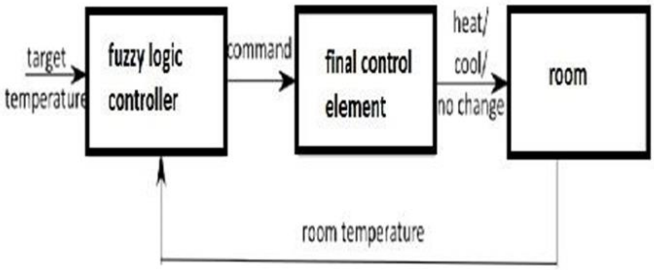

Fig 2 : Fuzzy logic system

In order to exemplify the usage of a fuzzy logic system, consider a temperature control system controlled by a fuzzy logic controller. The temperature of the room can be adjusted by details like current temperature of the room and the target value by defined system. The comparison between the room temperature and the target temperature can be compared by fuzzy engine at certain period of time and produces a command of heating or cooling.

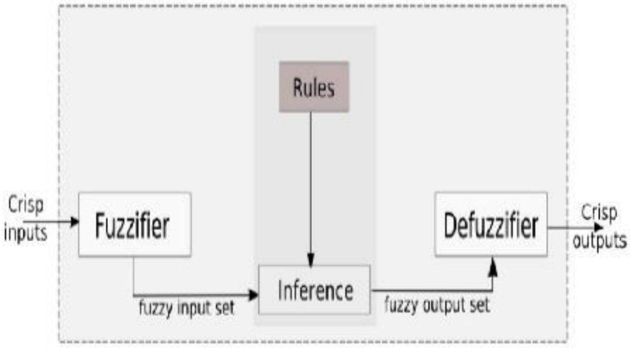

Fig 3 : A simple fuzzy logic system to control room temperature

Fuzzy logic algorithm

1. Define linguistic variables and terms
2. Construct the membership function
3. Construct rule base
4. Convert crisp data to fuzzy values using the membership
function
5. Evaluate rule in the rule base
6. Combine the result of each rule
7. Convert output data to non fuzzy values

Fuzzy set:

Before understand fuzzy set little terminology is necessary to understand.

Set: Objects having one or more similar characteristics can be collected and classified into set.

Member: objects belonging to a set call member of the set.

In fuzzy set member have their membership grade associated with it. For example set of HOT temperature is decide between 60< TEMP< 80. If temperature is 60 degree then we say it is not belong to HOT set but in fuzzy logic it is belong to set but having membership grade 0. Similarly if temperature is 62 and 78 then it belong to fuzzy set with membership grade 0.10 and 0.90 respectively i.e. First member is not more likely belong to HOT set but 78 temperature is most likely belong to the set HOT.

Membership Function:

Implementation of membership function is vital in the fuzzification and defuzzification steps of a FLS, to evaluate the non-fuzzy input values to fuzzy linguistic terms and vice-versa. A membership function is implemented to measure the linguistic term. For instance, membership functions for the linguistic terms of temperature variable are plotted. The staggering feature of the fuzzy logic lies in fuzzification of the numerical value which needs not to be fuzzified using only one membership function, so the value can be defined by various set at one particular instance. As below figure suggests, with different degree of memberships facilitate in such a way that a single temperature value can be considered in two different aspects at the single time.

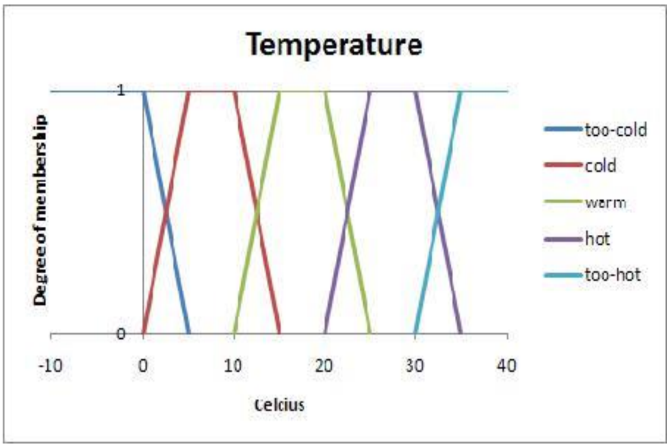

Fig 4 : Membership Functions for T (temperature)

Fuzzy Rules

In a Fuzzy Logic, a rule base is constructed to control the output variable. A fuzzy rule is a simple IF-THEN rule with a condition and a conclusion.

In Table 2, sample fuzzy rules for the temperature control system in Figure are listed

Sr. No	FUZZY RULES
1	IF(temperature is cold OR too-cold) AND (target is warm) THEN command is heat.
2	IF (temperature is hot OR too-hot) AND (target is warm) THEN command is cool
3	IF (temperature is warm) AND (target is warm) THEN command is heat

Table 2 : Sample fuzzy rules for temperature control system

Temperature/target	Too-cold	Cold	warm	Hot	Too hot
Too-cold	No change	Heat	Heat	Heat	Heat
Cold	Cool	No-change	Heat	Heat	Heat
Warm	Cool	Cool	No-change	Heat	Heat
Hot	Cool	Cool	Cool	No-change	Heat
Too-hot	Cool	Cool	Cool	Cool	No-change

Row captions in the matrix contain the values that current room temperature can take, column captions contain the values for target temperature, and each cell is the resulting command when the input variables take the values in that row and column. For instance, the cell (4, 5) in the matrix can be read as follows: If temperature is warm and target is hot then command is heat.

Fuzzification: Fuzzification is the process of making crisp quantity fuzzy.

Defuzzification: The procedure of producing a quantitative outcome in fuzzy logic, given fuzzy sets and corresponding membership degrees can be described as term “Defuzzification”. It is basically required in fuzzy control arrangements. These arrangements will contain large number of rules which will convert a number of variables into a fuzzy result and eventually the converted variables called results are expressed in terms of membership in fuzzy sets. To understand this, rules contrived to determine how much pressure to enforce might result in "Decrease Pressure (13%), Maintain Pressure (33%) and Increase Pressure (70%)". Defuzzification is rendering the membership degrees of the fuzzy sets into a particular conclusion in other words, real value.

III. RESULTS AND DISCUSSION

3.1. Implementation of fuzzy logic Fuzzification of Input

In the fuzzification process, a real scalar value changes into a fuzzy value. Arrangements of Fuzzy variables ensure that real values get translated into fuzzy values. After translating those real values into fuzzy values, the possible outcome is called “linguistic terms”. The input linguistic variables for Fuzzy Logic Temperature Controller (FLTC) suggest two things. First it shows linguistically the difference between the set point and second it also expresses the measured and calculated signals from a temperature sensor. Input to FLTC is Error= (Set point-Temperature sensed). For fuzzified input, two functions including trapezoidal and triangular are used. To determine the range of fuzzy variables according to the crisp inputs is the primary requirement for proper running of the fuzzier program. Temperature difference which was sensed previously, is restricted to positive value. The following fuzzy sets are used: NEG =negative, SNEG=small negative, ZERO= zero, SPOZ=small positive, POZ= positive. Table suggests the Membership function for input linguistic variable. Membership functions for input linguistic variable.

Table 4 : Input linguistic variables

No.	Crisp Input Range (Error = Set Point – Current Temperature)	Fuzzy Variable Name
1	-15 to -50	NEG
2	0 to +30	SNEG
3	-15 to +15	ZERO
4	0 to +30	SPOZ

To include the linguistic variable negative (Neg) to a microcontroller, transformation of the pictorial representation into substantive code is needed.

Fuzzy Membership Functions for Outputs

The output linguistic variables express linguistically the applied values to the FLTC actuators for temperature control. Present study considered typically one output variable, which is a PWM Wave for fan and Heater. In this case it is essential to attribute fuzzy memberships to yield variable, which has to be identical to the input variable. The fuzzy sets used for PWM Wave are as follows: Z = zero, L = large, M = medium, H = high, VH = very high.

Table 5: Output linguistic variables

No	Fuzzy variable range output	Corresponding	Fuzzy variable name
1	165.75to255	65%to100%	VH
2	127to204	50%to80%	H
3	165.75to89,25	65%to35%	M
4	127to51	50%to20%	L
5	89.25to0	35%to0%	Z

Rule block

Once the current values of the input variables are fuzzified, the fuzzy controller continues with the phase of "making decisions," or deciding what actions to take to bring the temperature to its set-point value. For the action to be initiated the measures are minimal time as well as minimal temperature.

The restraint policy of a Fuzzy Control System is comprised by the rule blocks. In the rules 'IF' part depicts the situation, for which the rules are projected. The following 'THEN' part delineates the reaction of the fuzzy system in this state. The control policy of heater is structurally formulated according to fuzzy rules. For example, rule 1 "If error is NEG then firing angle is Z"

Table 6 : Fuzzy rules

No	Fuzzy variable range output	Corresponding	Fuzzy variable name
1	165.75 to 255	65% to 100%	VH
2	127 to 204	50% to 80%	H
3	165.75 to 89.25	65% To 35%	M
4	127 to 51	50% to 20%	L
5	89.25 to 0	35% to 0%	Z

Defuzzification

The outcome of defuzzification has to be in a numeric form so that it defines the PWM Wave of the MOSFET which is used to force the fan and heater. Out of the number of ways to execute defuzzification; in the given scenario, weighted average defuzzification is the best technique to

$$D = \Sigma P(i) \square W(i) / \Sigma W(i) ....$$

W[i] =The Weight associated with rule.

The degree of each membership function which was computed in the previous step of fuzzification is encountered by the subprogram called "Defuzzify" and this after certain process it returns defuzzified output. This defuzzify output is employed to restraint the pulse width modulation wave of MOSFET.

3.2. Pulse width modulation technique

The temperature System has a Heater coil and a Fan. The heater assembly consists of an iron plate placed at a distance from a nichrome coil. When current passes through the coil it gets heated and in turn raises the temperature of the iron plate. We are interested to alter the heat generated by the coil and also the speed at which the fan is operated. The amount of power which is to be delivered to fan and heater can be assured by several methods.

We using the PWM technique Modulation of the square wave which is in duty cycle is done by Pulse Width is in duty cycle is done by Pulse Width Modulation action

Duty cycle = T_{ON} / T

Where;

T_{ON} : ON time of the wave

T : Total time period of wave Power delivered to the load is proportional to T-ON time of the signal

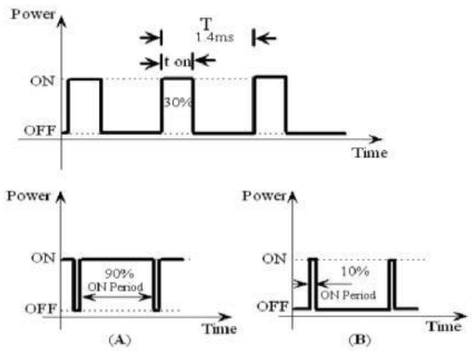

Fig 5. Pulse width modulation

An 80% duty cycle indicates that fan is ON 80% of the time and OFF 20% of the time. The relation between the speed of the fan and the value of the applied pulse width modulation duty cycle is in direct proportion. In other words a high duty cycle will produce high speed.

3.3 Outcome of temperature control using fuzzy

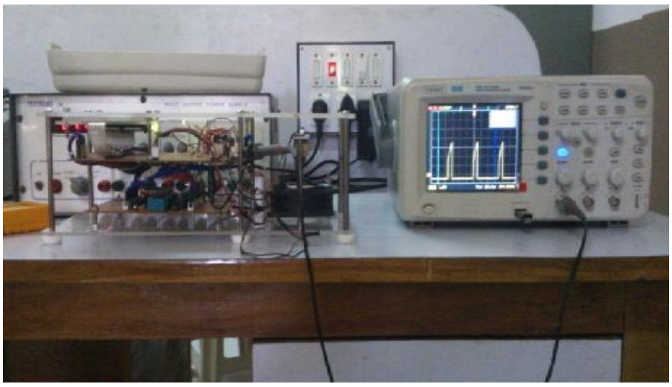

Fig 6 : Overall view of system

The Temperature in the case study is as follow:

Set temperature: 45˙ C

Current temperature: 46˙ C

Fig 7 : LCD display

Error = SP – CV = 45 - 46 = -1

Rule base Follow: Rule-2(SNEG) and Rule-3(ZERO)

Therefore Fuzzilization value f2=0.04

f3=0.933

Defuzzilization value Z^* = 130.95

The Duty Cycle of HEATING COIL current = 49%

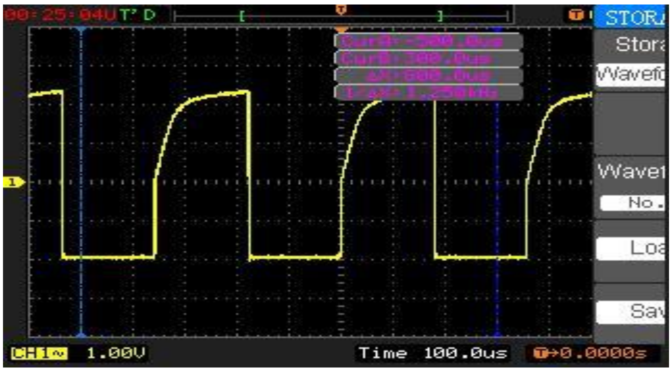

Fig 8 : Graph of PWM

IV.CONCLUSION

In this dissertation fuzzy temperature controller is defined and implemented in microcontroller without using any special software tool. Unlike some fuzzy controllers with hundreds or even thousands of rules running on computer systems. A unique FLC using a small number of rules and simple implementation is demonstrated to solve a temperature control problem with unknown dynamics or variable. Fuzzy logic provides a completely different way to approach a control problem. This technology is not difficult to apply and the results are usually quite interesting. Thus Fuzzy logic is one of the most interesting approach to control the temp in microcontrollers.

In this thesis we have shown the control behaviour of many fuzzy control system including temperature plant. Then we tabulated the final results of the above-mentioned various control system. Non isolated high step up DC-DC converter with pulse width modulation technique is presented in this paper. The voltage doubler rectifier is used to step up the voltage. This simple and effective techniques give many desirable features for high efficiency and high step up applications.

The proposed converter topology and control techniques can be a promising solution for high step-up applications. Here we have compared the result obtained by both PID (PROPORTIONAL INTEGRAL DERIVATIVE) and Fuzzy logic control. Thus PID (PROPORTIONAL INTEGRAL DERIVATIVE) control gives us the best result than Fuzzy control.

V. REFERENCES

[1]. L. A. Zadeh, Fuzzy sets,Information and Contro l, 8 (1965)338-353.
[2]. K. Atanassov, Instuitionistic Fuzzy Sets : Theory and Applications,Springer Physica-Verlag, New York,1983.
[3]. K. Atanassov, G. Gargo, Interval - Valued instituitionistic fuzzy sets system, 31 (1989) 343-349.

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