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Automatic Control of Fan Speed using Fuzzy Logic

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ABSTRACT
This paper gives you the design as well as the simulation of an electric fan speed control by using fuzzy logic. This provides a clear view of how speed control is done based on data from the temperature sensor using fuzzy logic. In this we used data from analysis and verified it with different mathematical formulas. In this paper the input was taken into fuzzifed form and converted into a defuzzifed value to get the output by following certain rule blocks. In mythological analysis we considered 3 stages, Fuzzification of Input, Rule Block were defined, Defuzzification , to get the output.
Keywords: Fuzzy logic, Fuzzy logic controller, Temperature sensor.

Introduction

Electric Fan is a very simple device that consists of rotating blades used to move air in the room. As compared to A.C., fan don't change the temperature of air they only move it. Many system used in our daily life are non linear and it becomes really difficult to represent Non-linear system mathematically. it is a non-linear system, as we are considering to rotate it according to the environment temperature. We have tried to make a fuzzy inference system that has been used without any failure in establishing the relation between environment temperature and fan speed. Due to the shortage of electricity supply, we have to start research in areas where energy can be used efficiently. In households during summer, A.C. is responsible for 60-70% of our summer electricity bill [HYPERLINK \l "Ari07" 1]. The window A.C. that has been mostly employed uses 500 to 1440 watts2]**}**.In comparison, an electric fan uses only 90 watts, depending upon the speed and size [HYPERLINK \l "htt" 3]. Electric fan is a device that helps us to stay cool in summer while saving our money as well as protecting the environment by limiting the release of Carbon-di-oxide. In this paper the idea to use fuzzy logic came from the fact that temperature cannot be defined accurately. While all the regularly used system are defined by mathematical equations. Temperature control system is shown in figure 14].

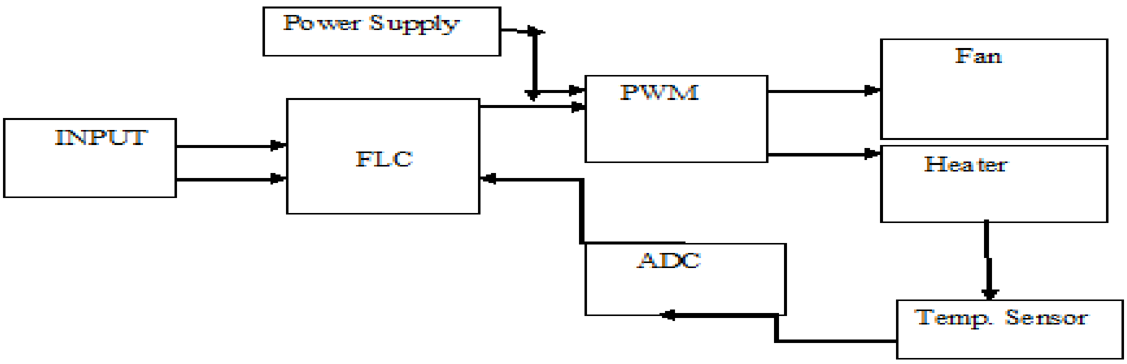

Figure 1

The temperature of the metal plate decides the amount of current that can pass through it. Temperature in the metal plate is measured with the help of temperature sensors. The amount of energy supplied to the fan is controlled by PWM technique.

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Fuzzy Logic System

Fuzzy logic can be defined as a system that creates mathematical logics using values between 0&1.Fuzzy logic has been widely employed in controlling of machines. Some of the Keywords used are explained: Fuzzy system-It is a mathematical system that reads analog inputs and responds to them. Fuzzy Controller-It helps in controlling a system based on fuzzy logic. It consists of 3 stages [HYPERLINK \l "Ali12" 5] , Input Stage, Processing Stage, Output Stage. Input Stage reads temperature sensor or other inputs like switches to required value of membership function. Processing stage creates rules and generates a result for each rule and analyses the results of different rules. Output stage converts the analysed result into the specific output value.

Fuzzy Inference System

It is the process which formulates and maps a input to an output with the help of fuzzy logic.

A fuzzy logic system is shown in figure 2 [6],

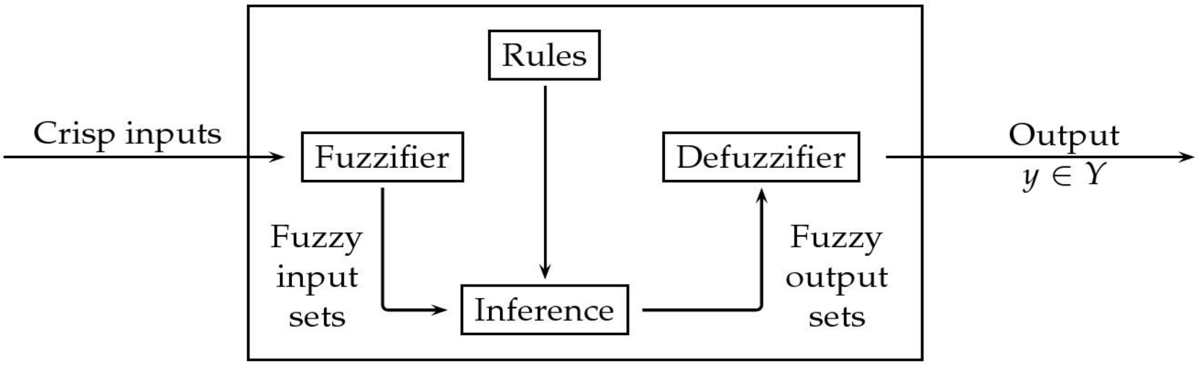

Figure 2

In order to demonstrate the use of fuzzy logic system, take into consideration a temperature system controlled by fuzzy logic. The temperature of the room can be controlled by this by taking certain details into account.

Fuzzy Rules

In fuzzy logic rules are set up to take control of the output. The rules in fuzzy logic are simple with an if-else condition having a condition and the target [4].

Table-1 Fuzzy Rules

Temperature/ Required Temperature	Too-cold	cold	warm	hot	Too-hot
Too-cold	-	Start Heating	Start Heating	Start Heating	Start Heating
cold	Start cooling	-	Start Heating	Start Heating	Start Heating
warm	Start Cooling	Start Cooling	-	Start Heating	Start Heating
hot	Start Cooling	Start Cooling	Start Cooling	-	Start Heating
Too-hot	Start Cooling	Start Cooling	Start Cooling	Start Cooling	-

Fuzzification: It is the process of making crisp quantity fuzzy [7].

Defuzzification: Defuzzification is interpreting the membership degrees of the fuzzy sets into a specific decision or real value. The simplest but least useful defuzzification method is to choose the set with the highest membership, in this case, "Increase Pressure" since it has a 72% membership, and ignore the others, and convert this 72% to some number [8].

Methodological Analysis

Fuzzification of Input: In fuzzification a scalar value transforms itself into a fuzzy value. Sequencing of the fuzzy variables helps in making sure that the values are transformed into fuzzy values. The output obtained after transformation is called “linguistic variables”.

Fuzzy logic temperature controller tells us about 2 things are, It gives the remainder between the set points and It gives the value obtained from temperature sensor.

In fuzzy logic temperature controller error can be given by

Error = Set point –Temperature sensed

Crisp inputs are the main requirement for the implementation of a fuzzy program.

The table 2 shows us some values of error and fuzzy variable given to that value [4],

Table 2. Fuzzy values of Error

S.No.	Error	Fuzzy Variable
1	-15 to -50	Negative
2	0 to +30	Small Negative
3	-15 to +15	Zero
4	0 to +30	Small positive
5	+15 to +50	Positive

Membership functions for output: Output linguistic variables tell us about the linguistic variables applied to the FLTC actuator for the control of temperature. Our study took into account the variables for heater. In this, we have to attribute fuzzy memberships to give us variables which are same as the input variables [4].

Table 3. Defuzzified Values

S.No.	Output range	Variable Name	Width modulation
1	165.75 to 255	Very High	65% to 100%
2	127 to 204	High	50% to 80%
3	165.75 to 89.25	Medium	65% to 35%
4	127 to 51	Low	50% to 20%
5	89.25 to 0	Zero	35% to 0%

Rule Block: The fuzzified input variables are continuously controlled by fuzzy controller. The fuzzy controller keeps on taking decisions to keep the temperature to a set point value. The Rule block help in making the fuzzy control system work with certain limitations [9].

Defuzzification: The defuzzification output should define the PWM that has been forced to the heater. Defuzzification can be best obtained by taking the average value of defuzzification, to get the crisp values. PWM is used to control the current flowing through the heatin element and the fan.An 80% cycle indicates that fan is ON 80% of the time and Off for 20% of the time.

Flowchart of the System

A pictorial representation of the flowchart is shown below as figure 3 [10],

- 0<Temp.<10 , Fan speed is slow
- 10<Temp.<20 , Fan speed is medium
- 20<Temp.<30 , Fan speed is fast
- 30<Temp.<40 , Fan speed is very fast
- Temp.<0 , Fan stops

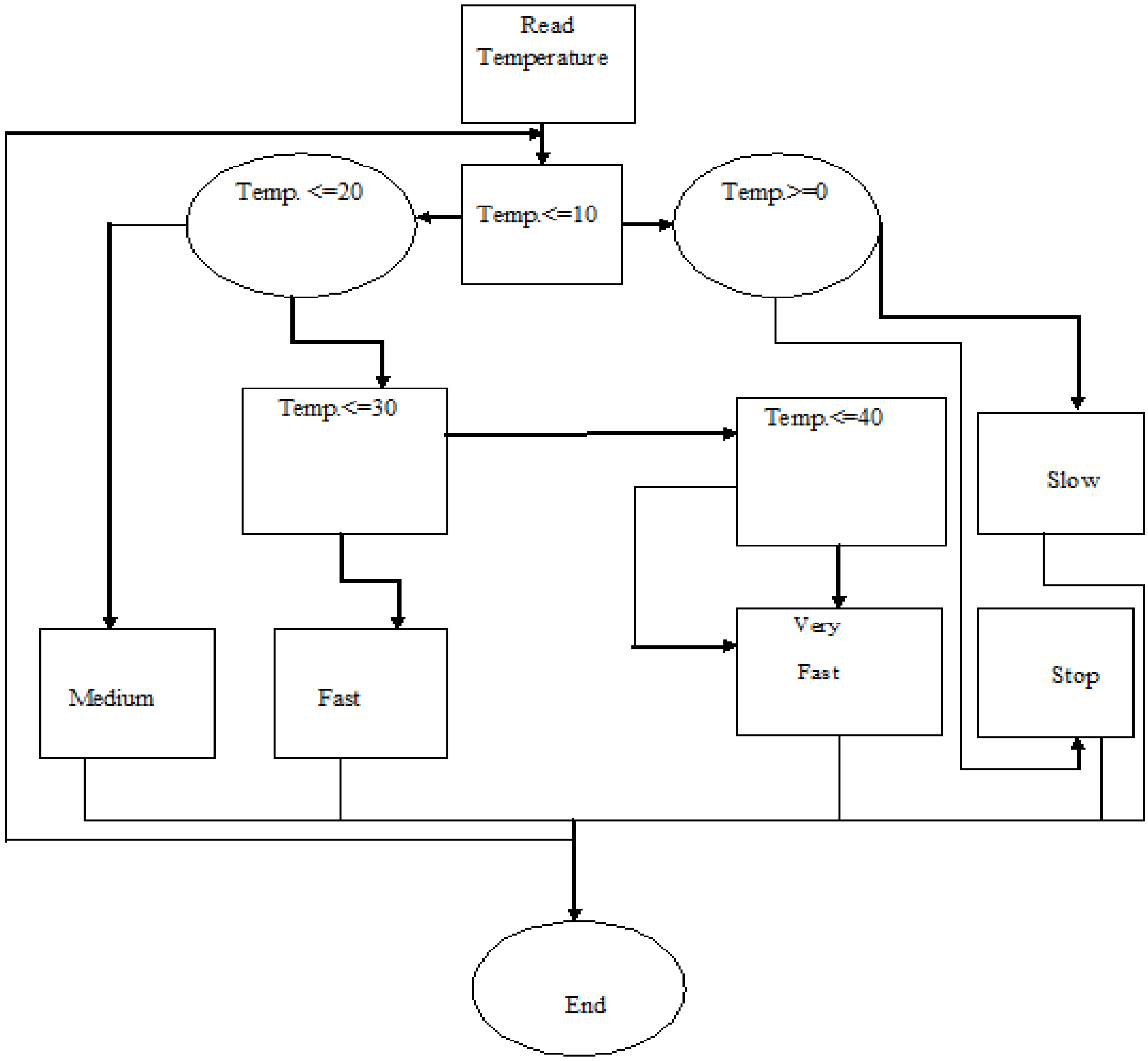

Figure 3

Result

The set point temperature, i.e., which has been set by us, Set Temperature is 480 C, The temperature of the room at that point of time is Current Temperature = 540 C. Error is calculated as follow, Error = ST - CT = 48 – 54 = -60 C. The input value for the system are, Fuzzy Value F2 = 0.06, F3 = 0.981. The output values of the system are, Defuzzified Value is 132.33 and Duty Cycle of Heating Current is 54%.

Conclusion

A simple design of automatic speed control of fan based on room temperature using fuzzy logic temperature controller has been proposed in this paper. The system is working nicely and the design has been made according to the available technology. The speed of the fan adjusts itself automatically. In our implementation we took input in the fuzzified form and output was defuzzified. This experiment has been performed to provide maximum human comfort. Fuzzy logic has given us the platform to improve control engineering in the future.

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