EE 8208 : INTELLIGENT SYSTEMS DESIGN

MINI PROJECT PART 1 REPORT

FUZZY LOGIC BASED TEMPERATURE CONTROLLER

SUBMITTED TO

Department Electrical and Information Engineering
Faculty of Engineering
University of Ruhuna

By

MAHINDAPALA D. P. P. - EG/2016/2916

Contents

1) INTRODUCTION

In a heating application, control of nonlinear processes of heating is required. Applying good control techniques can increase the life span of mechanical parts and also save energy by optimising the energy consumption. Different types of controller methods are used in industrial applications like On/Off control, proportional, integral and differential control (PID) and fuzzy logic based control [1].

2) PROBLEM STATEMENT

In this project I have selected an electric unit heater where the heating is controlled by an electric coil. Desired value of the temperature in the unit heater is 25 ^{0}C, where a range of 24-26 ^{0}C is also permitted. It is identified that the temperature of the environment can vary from -5 ^{0}C to 40 ^{0}C. Power input to the heating coil of the system is a pulse width modulation signal (PWM). This PWM signal to the heating coil needs to be given from the fuzzy logic based temperature controller.

3) METHODOLOGY

Using MATLAB, a simulation model of the heating system is created and fuzzy logic control is applied. I have set the controllers' parameters to values that result in the best performance under changes in temperature of the environment.

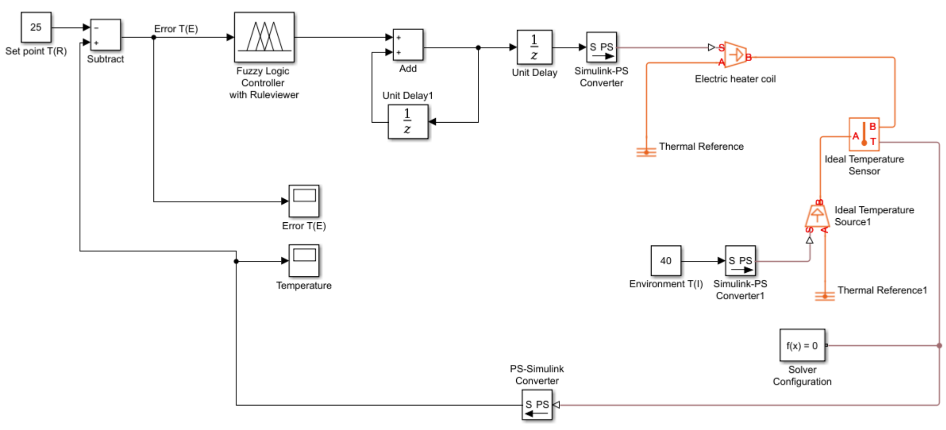

Figure 1 : Simulink model of the system

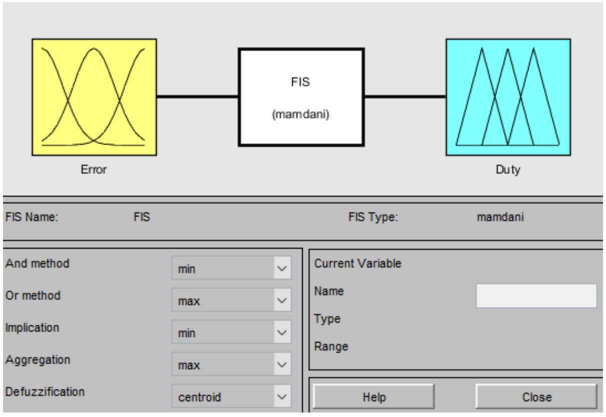

Figure 2 : Fuzzy Inference System

Fuzzy logic toolbox in MATLAB is used to enter membership functions and rule bases. Performance of the fuzzy logic controller was observed using the rule viewer.

Fuzzy input

In this system, the temperature is needed to be kept at a controlled value of 25 ^{0}C. It is taken that the temperatures are in the range of -5 ^{0}C to 40 ^{0}C. If the input temperature is T_I and the relative temperature is T_R, then the temperature error, T_E is given by,

$$T_E = T_I - T_R$$

Here T_R is equal to 25 ^{0}C.

Temperature error is given to the fuzzy logic controller as the input.

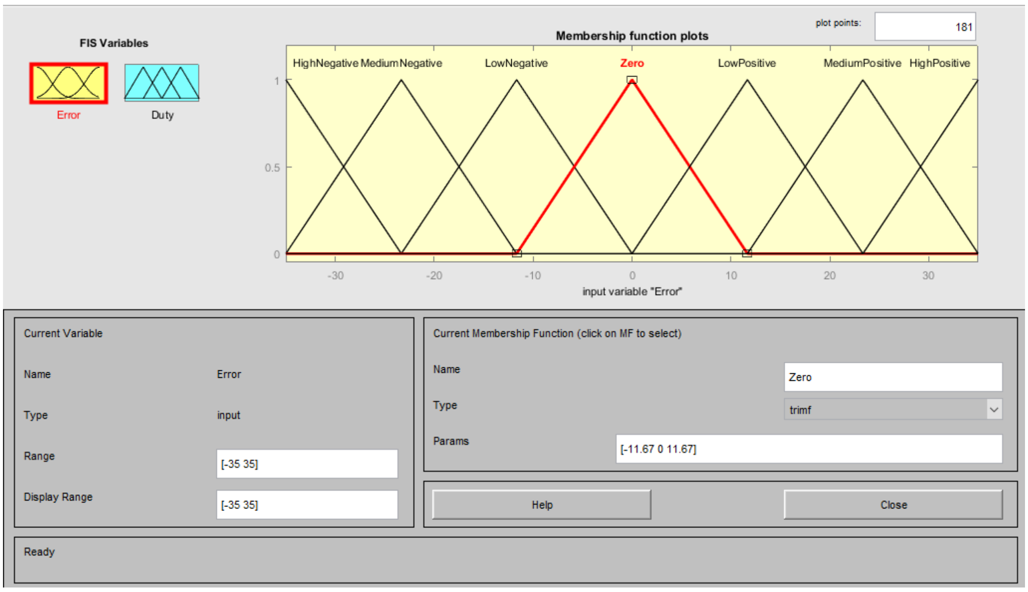

Figure 3 : Membership functions of the input Error

Fuzzy output

The output of the fuzzy logic controller is the PWM signal, which is given as the controller signal to the heater coil.

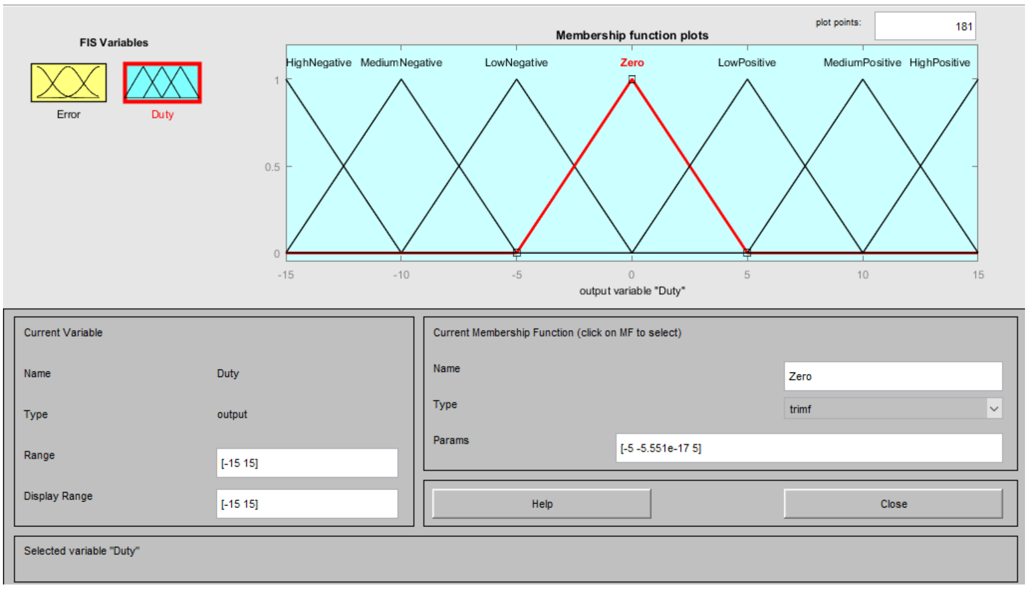

Figure 4 : Membership functions of the output Duty

Fuzzy inference rules

7 fuzzy inference rules were defined in the system as given in the following table

Table 1 : Fuzzy inference rules

Error	Duty
HighNegative	HighNegative
MediumNegative	MediumNegative
LowNegative	LowNegative
Zero	Zero
LowPositive	LowPositive
MediumPositive	MediumPositive
HighPositive	HighPositive

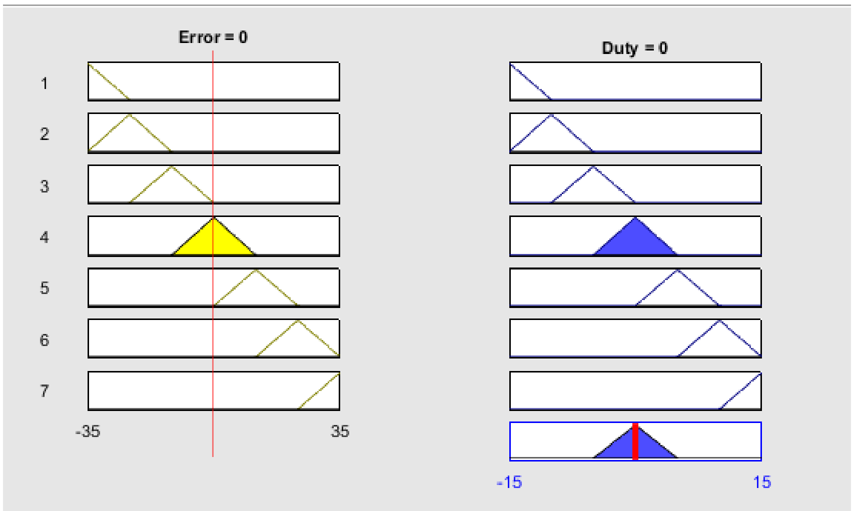

Figure 5 : Rule viewer of fuzzy logic controller

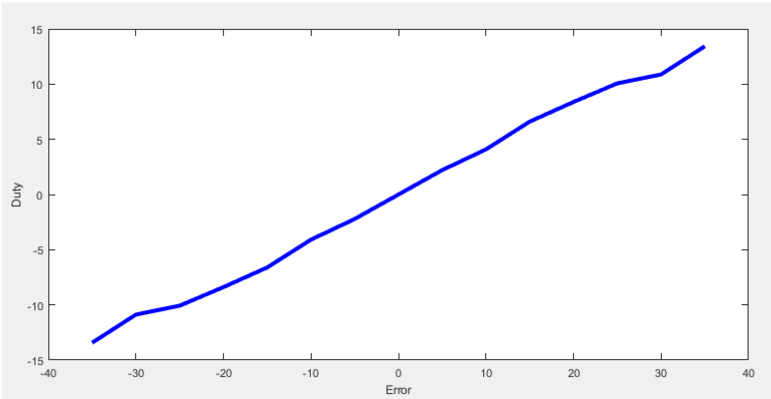

Figure 6 : Surface of the fuzzy logic controller

Fuzzy method

Mamdani method was used as the fuzzy controller method in this project. In the Mamdani method, input linguistic variables are linked to output variables using MIN MAX functions [2]. It is a method well suited to human input and has a more interpretable rule base.

4) RESULTS

Results of the simulation was observed while keeping the set point at 25 ^{0}C and changing the input temperature in the range -5 ^{0}C to 40 ^{0}C. Change of the temperature T can be observed as follows.

T_I = -5 ^{0}C

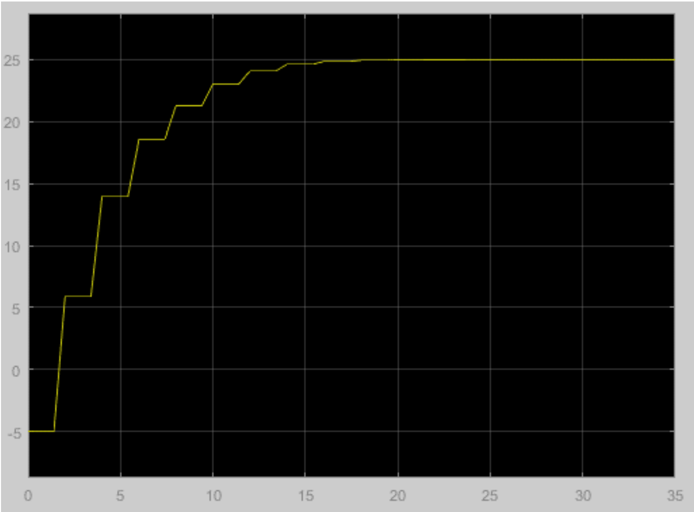

Figure 7 : Temperature when T_I is -5 ^{0}C

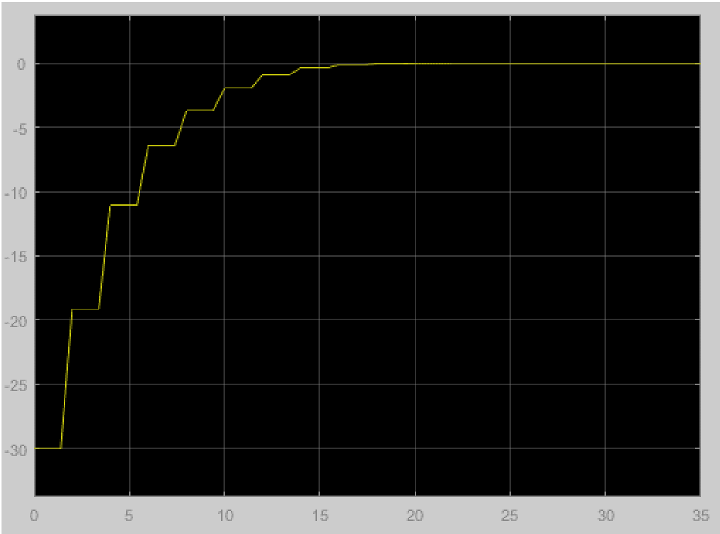

Figure 7 : Error when T_I is -5 ^{0}C

T_I = 40 ^{0}C

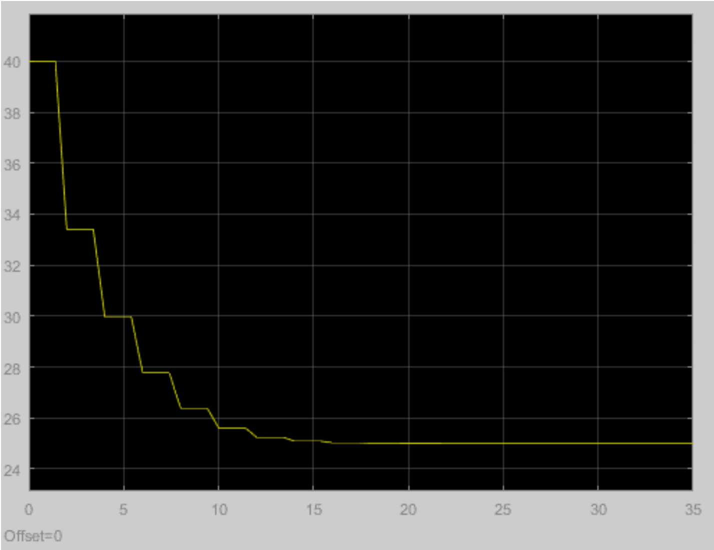

Figure 8 : Temperature when T_I is 40 ^{0}C

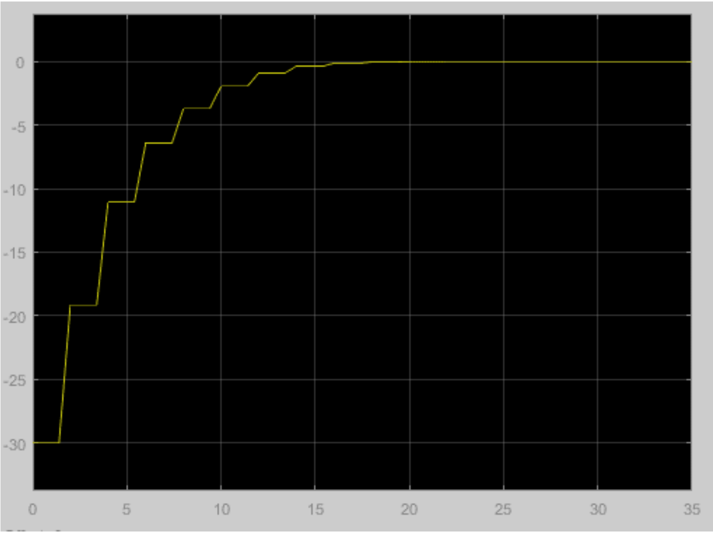

Figure 9 : Error when T_I is 40 ^{0}C

5) CONCLUSIONS

From the results obtained from the simulation, it can be seen that the temperature controller built using fuzzy logic is able to keep the temperature of the environment at the set point of 25 ^{0}C. Therefore the electric unit heater system can work as expected. It can be concluded that using fuzzy logic we can find a heuristic solution to the problem of controlling the temperature in the unit heater system. Further redesigning and fine tuning of the fuzzy sets and the membership functions can improve the results of the controller.

6) REFERENCES

[1] Gouda, M. M., Danaher, S., & Underwood, C. P. (2000). Fuzzy Logic Control Versus Conventional PID Control for Controlling Indoor Temperature of a Building Space. IFAC Proceedings Volumes, 33(24), 249-254.

[2] Basu, S. (2012). Realization of fuzzy logic temperature controller. International Journal of Emerging Technology and Advanced Engineering, 2(6), 151-155.