

Fuzzy Modelling

Exercise 10

Design a fuzzy Sugeno controller. The controller has two inputs and one output. The range of changes for the input signals are RX1, RX2 and for the output signal is RU.

The changes of the input signals are described using three symmetrical Gaussian membership functions. The changes of the output signal are described using constant functions with the following parameters NN [0 -1.5], N [0 -0.5], Z [0 0], P [0 0.5] PP [0 1.5].

The modal values of the Gaussian membership functions are equal: x_{1m1} , x_{1m2} , x_{1m3} and x_{2m1} , x_{2m2} , x_{2m3} . The width coefficients of the Gaussian membership functions are equal. The rule base contains nine rules.

Table 1. The rule base of the fuzzy controller

u	x1			
x2		N	Z	P
	N	NN	N	Z
	Z	N	Z	P
	P	Z	P	PP

R1: IF x1 is N AND x2 is N THEN u is NN

R2: IF x1 is N AND x2 is Z THEN u is N

R3: IF x1 is N AND x2 is P THEN u is Z

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R9: IF x1 is P AND x2 is P THEN u is PP

Determine the change in the characteristics of the controller for the following height of the intersection of the input membership function h_{x1} , h_{x2} .

Show in the graphic form:

- the model of the controller,
- the input Gaussian membership functions,
- the output membership functions,
- the rule base
- the characteristics of the controller.

a)

$$RX1 = [-5, 5] \quad x_{1m1} = -3 \quad x_{1m2} = 0 \quad x_{1m3} = 3$$

$$RX2 = [-6, 6] \quad x_{2m1} = -6 \quad x_{2m2} = 0 \quad x_{2m3} = 6$$

$$RU = [-2, 2]$$

case a1

$$h_{x1} = 0.5 \quad h_{x2} = 0.5$$

case a2

$$h_{x1} = 0.25 \quad h_{x2} = 0.25$$