

CHAPTER SEVEN

EFFECT OF FUZZY CONTROLLER'S PARAMETERS

7.1 Effect Of Membership Function Shape:

One of the most important parameters in designing fuzzy controllers is the shape and number of membership functions. The most commonly used membership function is triangular followed by Gaussian, trapezoidal and the Bell-shaped functions. The reason behind common use triangular and trapezoidal functions is the ease of their representation into embedded controllers. On the other hand, Gaussian and bell-shape membership functions are more suitable to represent linguistic terms in the fuzzy domain.

7.2 Simulation Results And Discussions:

In the following pages the simulation results shows the effect of some fuzzy controller parameters on IFOC of an IM. Those parameters include the shape and number of membership function (MFs). Only triangular, Gaussian and bell membership functions are considered for the shape.

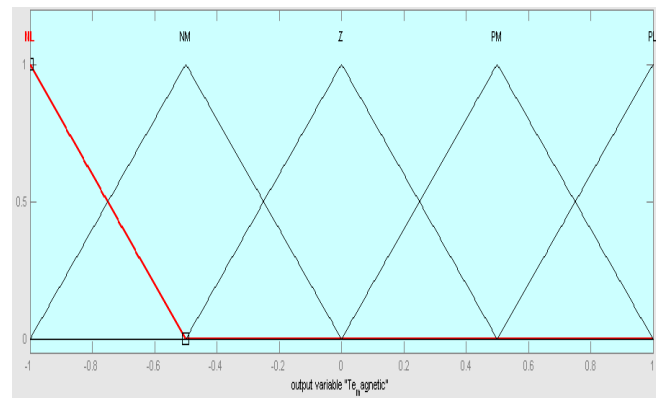
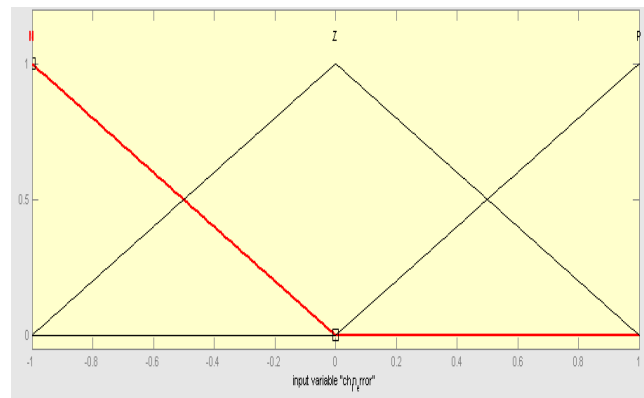
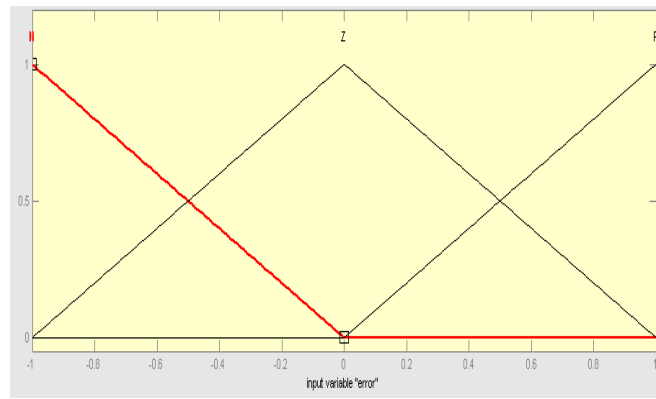


Fig 7.1 Triangular membership functions (3*3*5)for fuzzy controller input (e and ce) and output (ΔT_e).

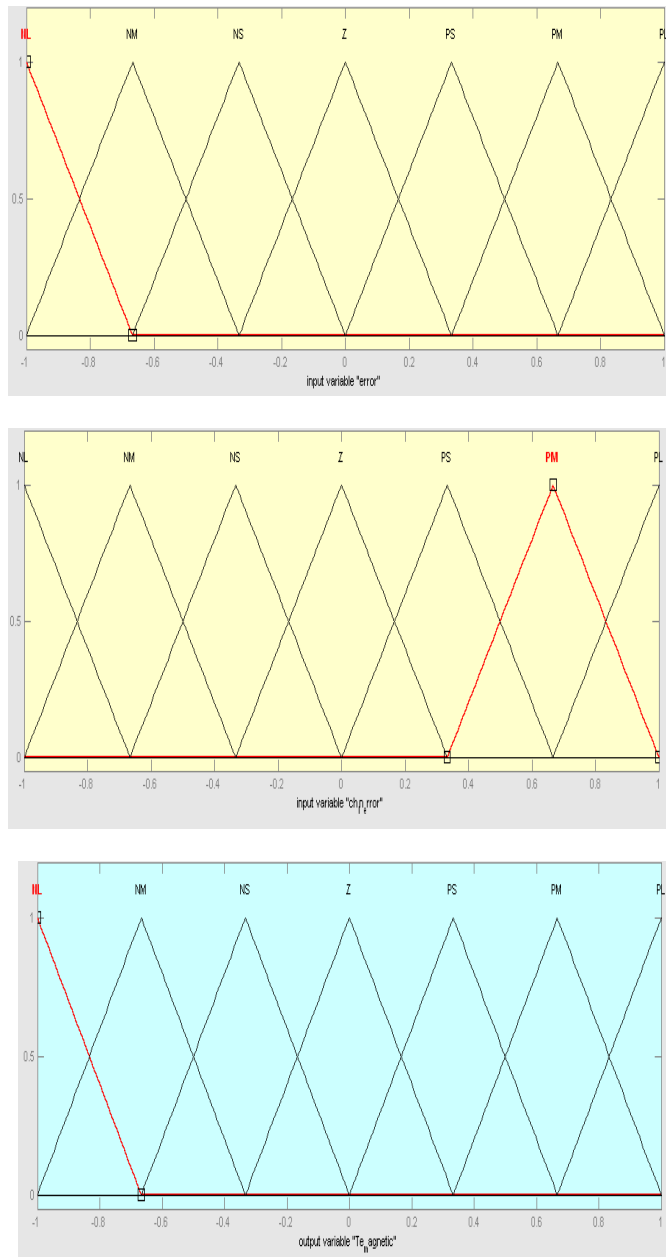


Fig 7.2 Triangular membership functions (7*7*7) for fuzzy controller input (e and ce) and output (ΔT_e).

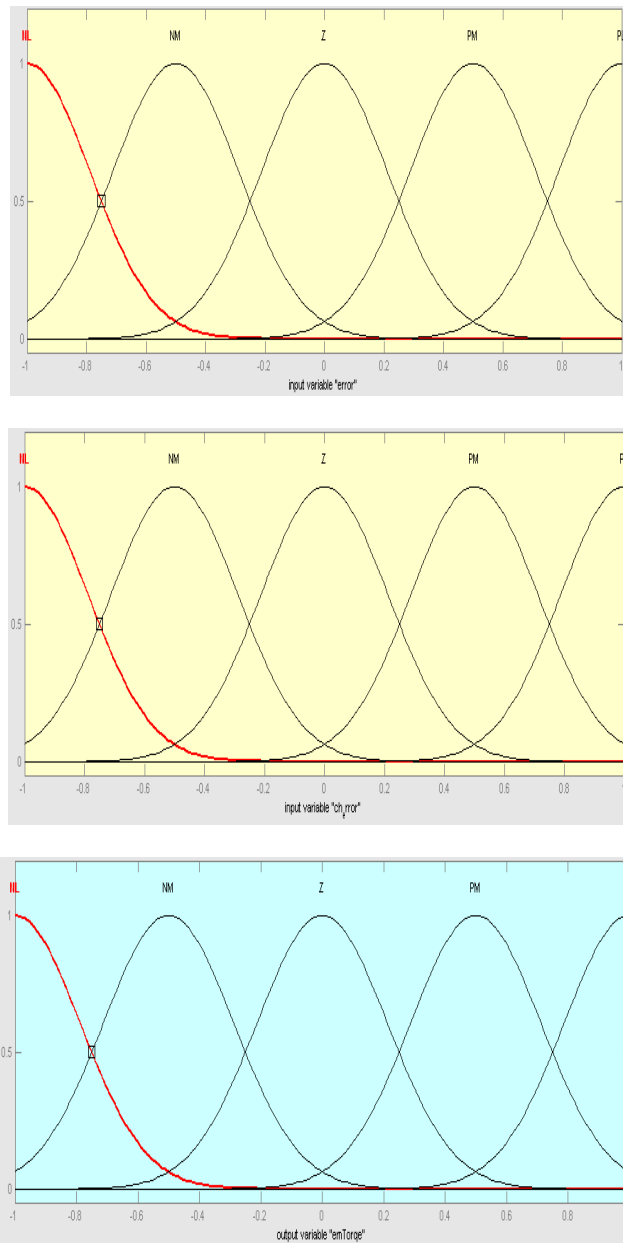


Fig 7.3 Gaussian membership functions(5*5*5) for fuzzy controller input (e and ce) and output (ΔT_e).

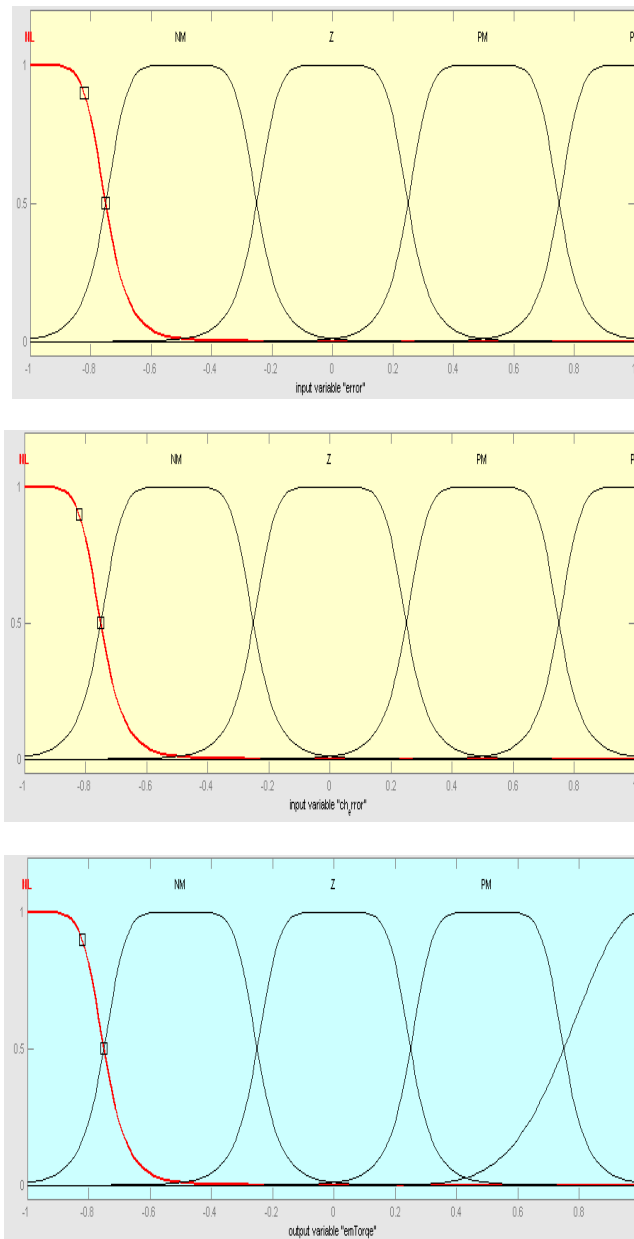


Fig. 7.4 Bell membership functions (5*5*5) for fuzzy controller input (e and ce) and output (ΔT_e).

The rules are driven by help of fuzzy inference systems in the Matlab/Fuzzy Logic Toolbox as mentioned before, then rules represented in rule tables.

Table 7.1 Fuzzy rules table of FC ($3 \times 3 \times 5$ memberships)

e ce	N	Z	P
N	NL	NM	Z
Z	NM	Z	PM
P	Z	PM	PL

Table 7.2 Fuzzy rules table of FC ($7 \times 7 \times 7$ memberships)

e ce	NL	NM	NS	Z	PS	PM	PL
NL	NL	NL	NM	NM	NS	NS	Z
NM	NL	NM	NM	NS	NS	Z	PS
NZ	NM	NM	NS	NS	Z	PS	PS
Z	NM	NS	NS	Z	PS	PS	PM
PS	NS	NS	Z	PS	PS	PM	PM
PM	NS	Z	PS	PS	PM	PM	PL
PL	Z	PS	PS	PM	PM	PL	PL

Many simulation tests were carried out on some fuzzy controller parameters, and their results were compared. Figure 7.5, and table 7.3 show the speed response of induction motor on full load.

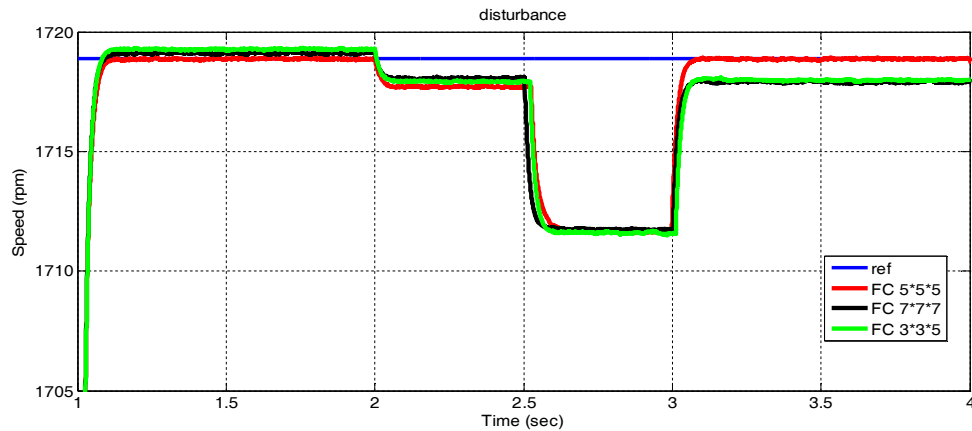


Fig. 7.5 : Speed response of the fuzzy controller based on sets ($3 \times 3 \times 5$, $5 \times 5 \times 5$ and $7 \times 7 \times 7$)

Table 7.3 summarizes numerical values of rising time , peak overshoot, time to the peak and settling time, as a result of effect of number of linguistic variables of fuzzy controller.

Table 7.3 the effect of the number of variables of FC

Property controller	Rising time (10%- -90%) (Sec.)	Settling time ± 2 (Sec.)	Overshoot (%)	Time to the peak (Sec.)
FC 3*3*5 Triangular	0.825	1.9960	0.0349	1.63
FC 5*5*5 Triangular	0.825	1.9800	0.0058	1.26
FC 7*7*7 Triangular	0.825	1.9975	0.0291	1.67

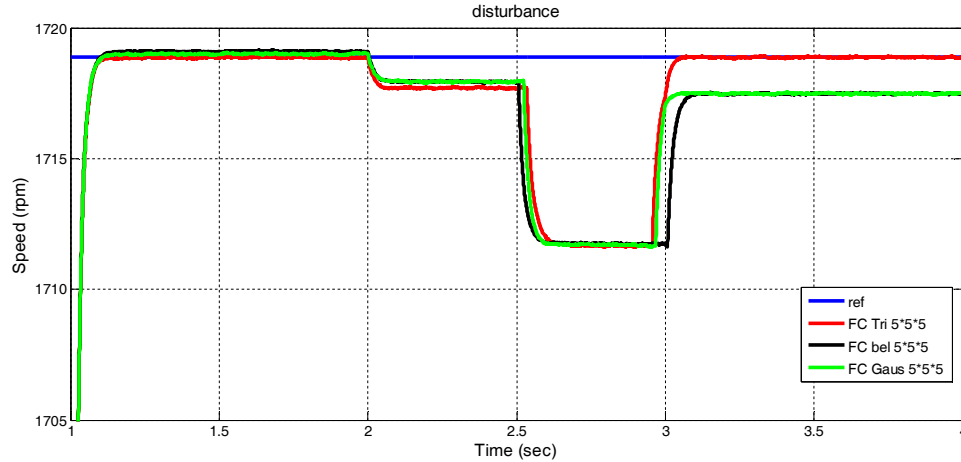


Fig. 7.6 The effect of type of membership function with disturbance of load

Table 7.4 summarizes numerical values of rising time , peak overshoot, time to the peak, settling time and drop in speed at disturbance of load, as a result of effect of shape type of membership function of fuzzy controller.

Table 7.4 The effect of type membership function of FC

Property controller	Rising time (10%-- 90%) (sce)	Settling time ± 2 (sec)	Overshoot (%)	Time to the peak (sec)	Drop in speed (e_{ds} %)
FC 5*5*5 Triangular	0.825	1.970	0.0058	1.27	0.3434
FC 5*5*5 Gaussian	0.825	1.980	0.0174	1.97	0.3667
FC 5*5*5 Bell	0.825	1.992	0.0291	1.66	0.3725

Using the triangular membership function for fuzzy controller shows better results compared to Gaussian and bell shape MFs. The performance of triangular membership function with number of linguistic variable (5*5*5) it is better than triangular MFs (3*3*5) and (7*7*7).