

Exercise: Maximum power point tracker for a wind turbine

Maximum Power Point Tracking (MPPT), or MPP controller or MPP tracker is a principle to follow the maximum power point of a nonlinear electrical generator. MPPT systems are generally associated with PV or wind generators.

We give you some illustrations of an MPPT control for a wind turbine with a permanent magnet synchronous machine.

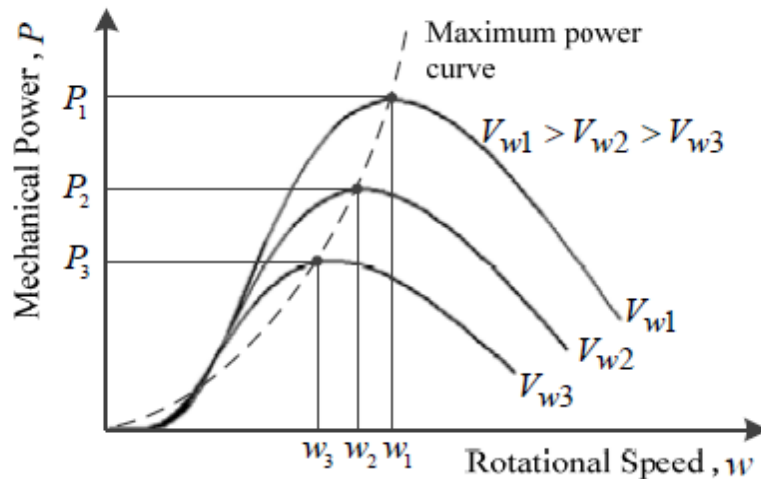


Fig. 1 . Wind turbine $P-\omega$ characteristics and maximum power curve.

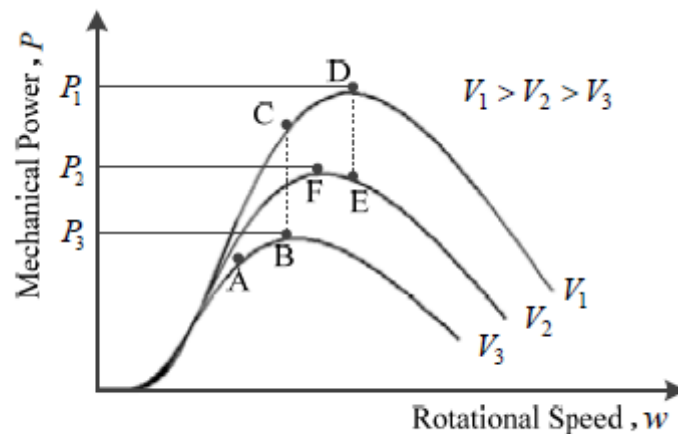


Fig. 2 . Principle illustration of control algorithm.

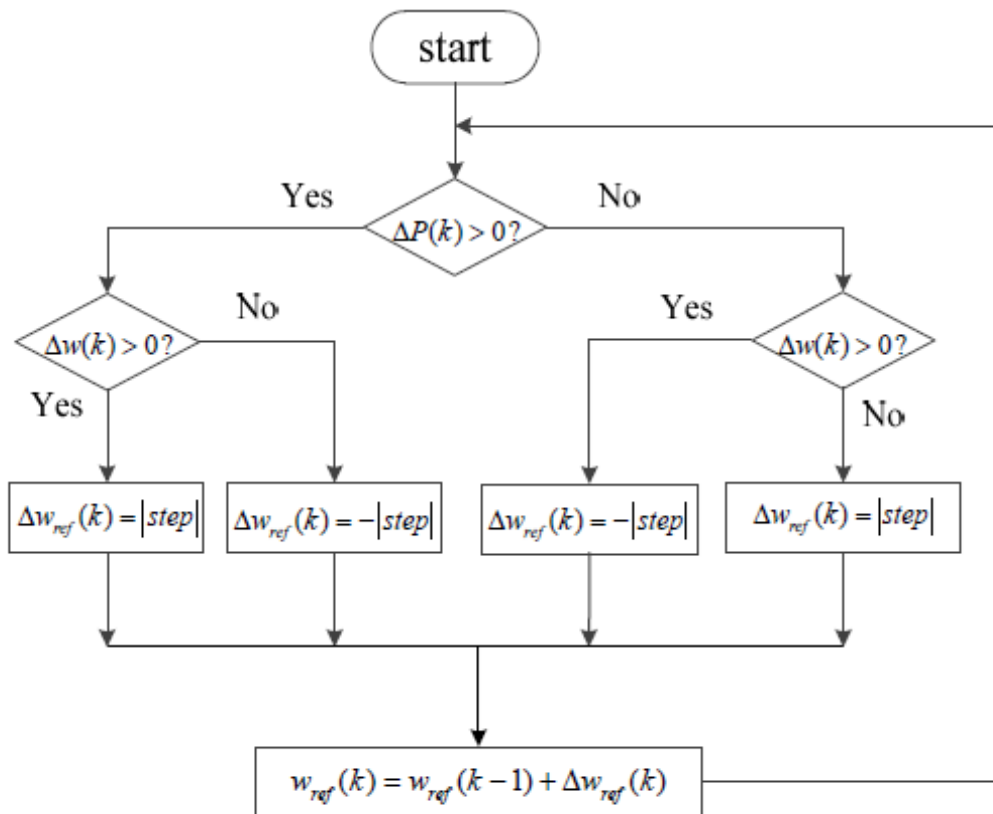


Fig. 3 . Flow chart of control algorithm

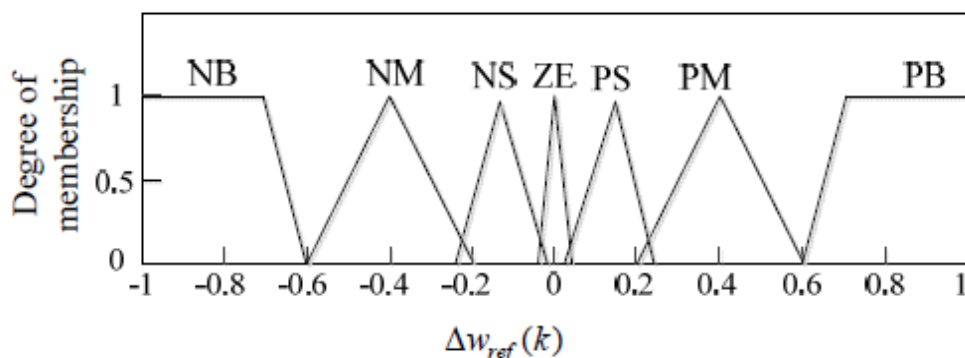


Fig. 4 . Member functions of output variable $\Delta w_{ref}(k)$.

We propose to develop a fuzzy MPPT controller for the wind turbine.

- 1) Explain the principle of proposed MPPT method.
- 2) Well define inputs and output.
- 3) Draw inputs and output membership functions with notations (such as N, Z, P or NB, NS, NM, PB, PM, PS, ZE). We suppose normalized variables with values between -1 and 1.
- 4) Cite at least five if then rules as example.

5) Complete this fuzzy logic rules table (Fuzzy Associative Matrix)

Table: Rules for the fuzzy logical controller

$\Delta w(k)$	$\Delta P(k)$						
	NB	NM	NS	ZE	PS	PM	PB
N	PB	.....	PS	.....	.....	.....	.....
Z	.....	.....	NS	.....	.....	.....	.....
P	.....	.....	NS	.....	.....	.....	PB

Correction

1) The basic principle of the Hill Climbing searching algorithm is : if the previous increment of rotational speed Δw results in an increase of mechanical power ΔP , the search of Δw continues in the same direction ; otherwise, the search reverses its direction.

2)

The set of the fuzzy logical controller is described as follows: the input variables are $\Delta P(k)$ and $\Delta w(k)$, while the output variable is $\Delta w_{ref}(k)$. $\Delta P(k)$ and $\Delta w(k)$ can be obtained by

$$\Delta P(k) = P(k) - P(k - 1)$$

$$\Delta w(k) = w(k) - w(k - 1) .$$

3)

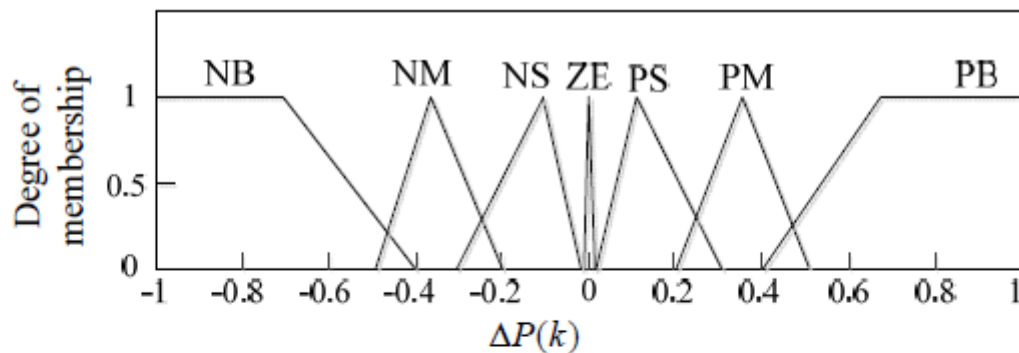
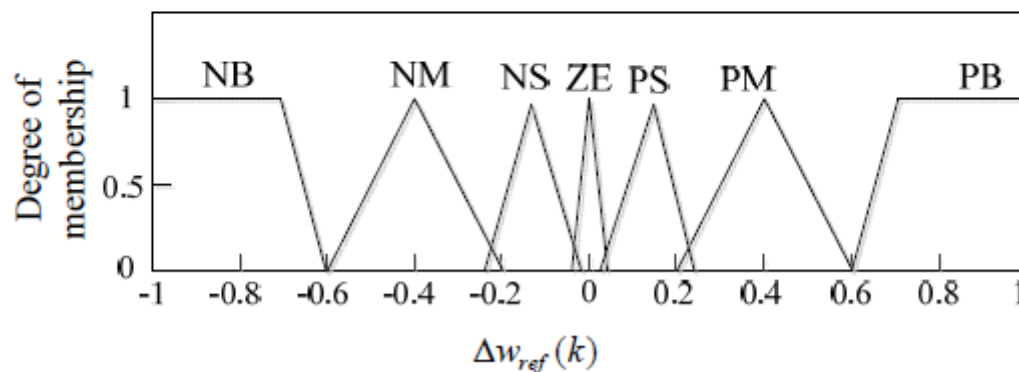


Fig. 7. Member functions of input variables $\Delta P(k)$.



Member functions of output variable $\Delta w_{ref}(k)$.

4)

If Δw is *N* and ΔP is *NB* then Δw_{ref} is *PB*

If Δw is *N* and ΔP is *NS* then Δw_{ref} is *PS*

If Δw is *Z* and ΔP is *NS* then Δw_{ref} is *NS*

If Δw is *P* and ΔP is *NS* then Δw_{ref} is *NS*

If Δw is *P* and ΔP is *PB* then Δw_{ref} is *PB*

5)

Rules for the fuzzy logical controller

$\Delta w(k)$	$\Delta P(k)$						
	NB	NM	NS	ZE	PS	PM	PB
N	PB	PM	PS	NS	NS	NM	NB
Z	NM	NS	NS	ZE	PS	PS	PM
P	NB	NM	NS	PS	PS	PM	PB