Ramblings from Hao

C Language Implementation for Proportional-Resonant Controller

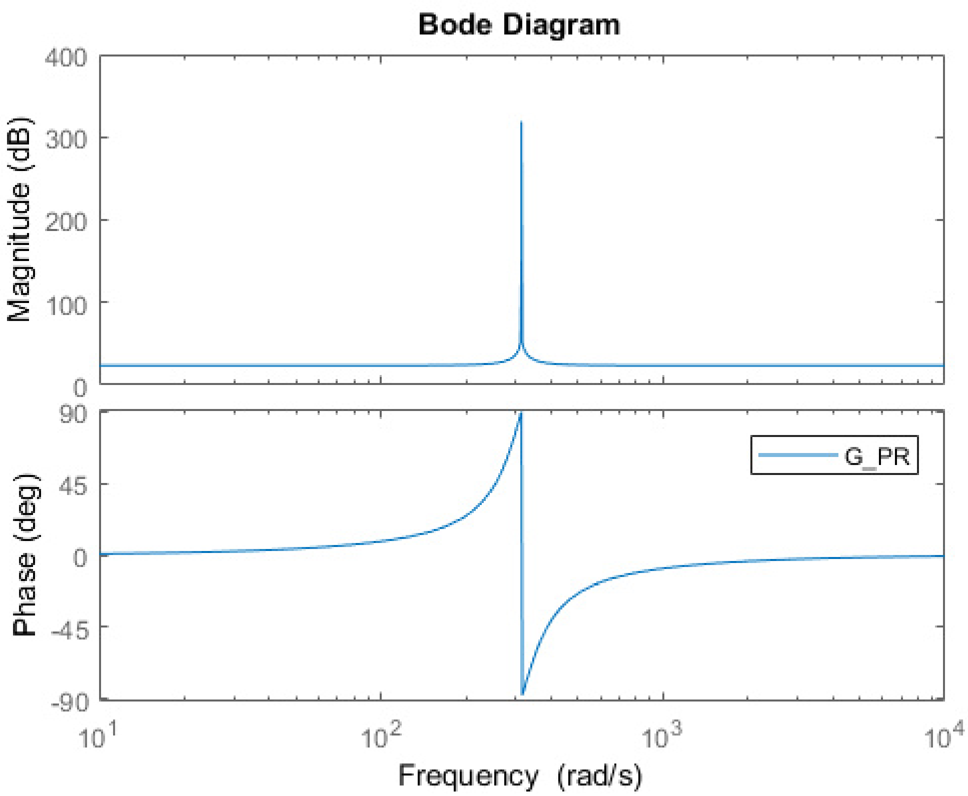
2018-06-22 | 2020-02-09 | Control | 0 Comments

1. Introduction to Proportional-Resonant Controller

First, let's see the transfer function of PR controller and its bode diagram :

$$G_{PR}(s) = K_p + \frac{K_r s}{s^2 + \omega_r^2}$$

where the ω_r is the resonant frequency.



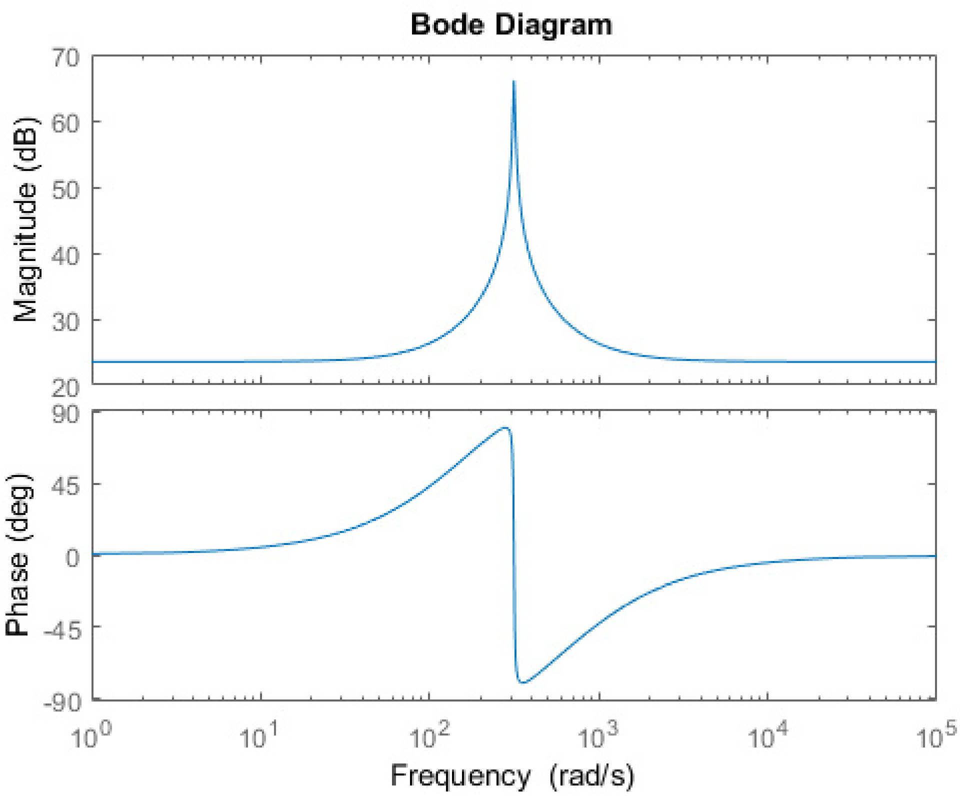
Bode diagram of PR Controller

As can be seen in the bode diagram, the gain at 50Hz (314 rad/s) is infinite, so PR controller can be used to track reference of specific frequency. However, the reference frequency is not always a constant, e.g. the frequency of electricity grid. In practice, Quasi-Proportional-Resonant can be used to solve this problem.

The transfer function of QPR and its bode diagram:

$$G_{QPR}(s) = K_p + \frac{2\omega_i K r s}{s^2 + 2\omega_i s + \omega_r^2}$$

where the addition of $2\omega_r$ reduces the gain at resonant frequency but increase the band width around resonant frequency.



Bode diagram of QPR Controller

You can change the parameter ω_r and run the demo code below to see how it changes the shape of bode diagram.

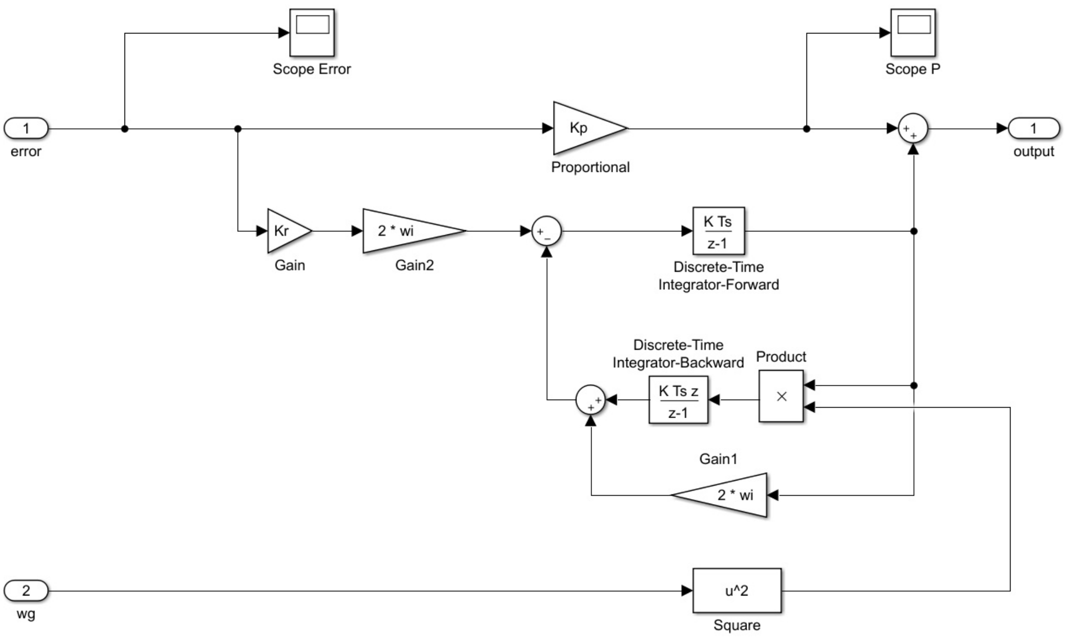
```
s = tf([1, 0], 1) ;

Kp = 15 ;
Kr = 2000 ;
wr = 50 * 2 * pi ;
```

```
wi = pi ;

G_PR = Kp + Kr * s / (s^2 + wr^2)
figure
bode(G_PR)

G_QPR = Kp + 2 * wi * Kr * s / (s^2 + 2 * wi * s +  wr^2)
figure
bode(G_QPR)
```

2. C Language Implementation

The code is in the repository Controller, feel free to use it for your own application.

The structure of QPR controller implemented is as below:



PR Implementation

As shown in Effects of Discretization Methods on the Performance of Resonant Controllers, the structure of QPR controller can be implemented using 2 integrators.

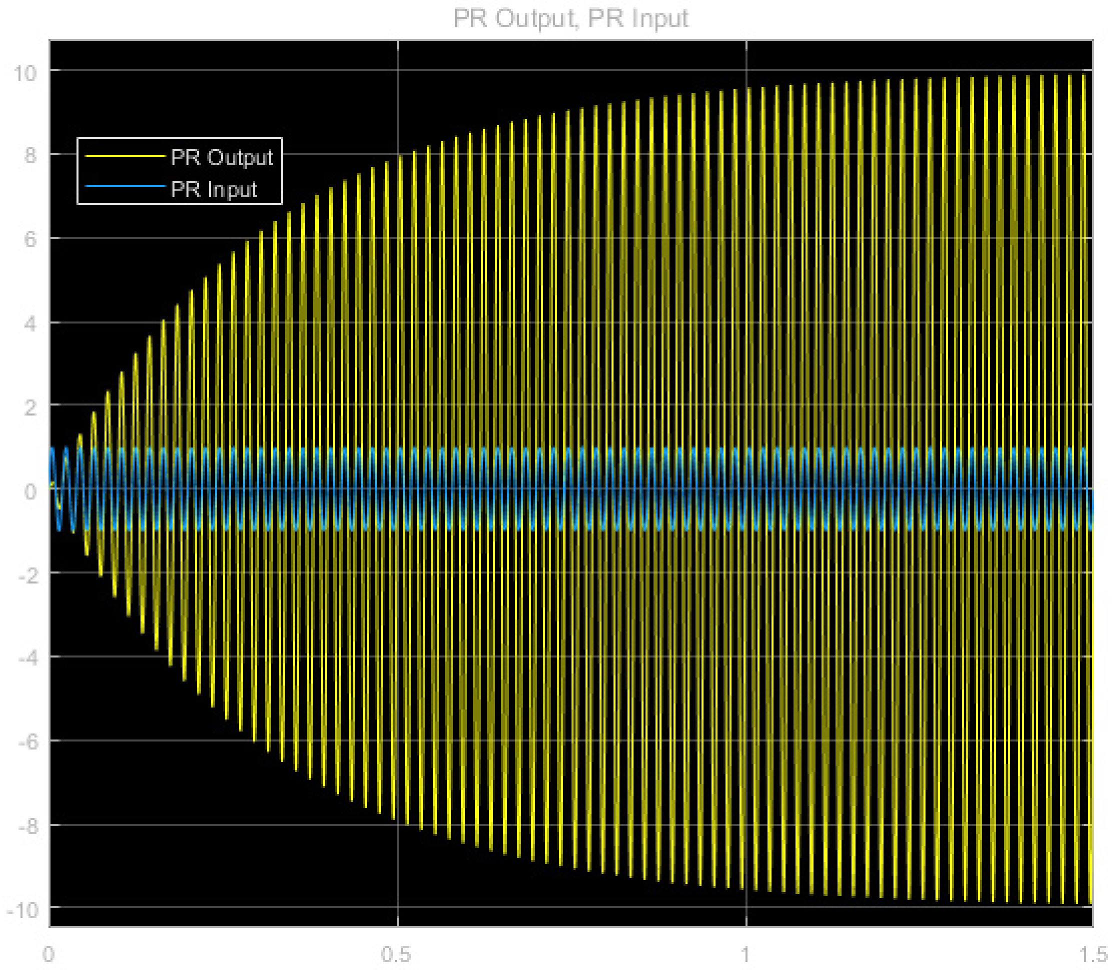
The implemented structure above has 2 advantages:

- Easy to implemented, 2 integrators used.
- Autonomous resonant frequency adaption: ω_r can be fed into the controller and real-time resonant frequency adaption is achieved.

You can run the Simulink demo to see the effectiveness of this structure

- Kp is set to be 0 and Kr to be 10
- ω_i is set to be $0.01\omega_r$

The simulation result is as below:



Simulation Result

As you can see in the result above, the input signal is a sine wave with an amplitude of 1 and the output with an amplitude of 10, corresponding to the parameter-- Kp is 0 and Kr is 10.

3. Reference

1.Effects of Discretization Methods on the Performance of Resonant Controllers

2.百度文库文档

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< 从伯德图(Bode Plot)说起

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