Applications of soft computing techniques based PID controller for different power system applications

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Abstract

In this review article, different soft computing techniques based PID controller will be analysed employed for the controlling of different power system applications. The power system applications such as control of terminal voltage of AVR system, speed control of DC motor and frequency control of single area system, are considered for the analysis. Through the responses, it may be observed that the soft computing techniques has shown superior results.

Introduction

The controller has to be designed properly for controlling of the different power system applications to have desired response from the system. Proportional-derivative-integral controller will be employed for different cases. Earlier days, the parameters of the PID controller is used to tuned by the classical method such as Ziegler Nichols method, Cohen-Coon method. In modern days, the gains of PID controller is being tuned by the different soft computing techniques which are population based techniques such as particle swarm optimization (PSO), ant bee colony (ABC), MOL, moth flame optimization (MFO) algorithm, whale optimization algorithm (WOA). Various applications have been considered for the analysis purpose such as automatic voltage regulator (AVR), speed control of DC motor and three area hydro power system.

PID Controller

The PID controller's model can be designed with the help of a transfer function, and in Laplace domain, it is presented in (9) where the parameters of controller show K_p, K_i and K_d which denotes the gain of proportional, integral and derivative respectively.

$$K_{PID}(s)=K_P+\frac{K_I}{s}+\frac{sK_d}{\xi s+1} \tag{1}$$

Applications

In this review paper, the power system applications which are assumed are AVR, speed control of DC Motor and single area power system.

Automatic Voltage Regulator

The block diagram of AVR is shown in Fig. 1 and the transfer function of its components are expressed below.

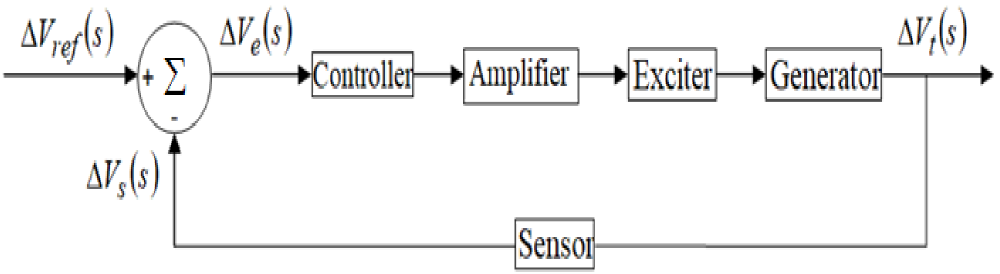


Fig. 1. AVR's block diagram

$$T.F._{Amplifier} = \frac{K_A}{1+sT_A} \quad (2)$$

$$T.F._{Exciter} = \frac{K_E}{1+sT_E} \quad (3)$$

$$T.F._{Generator} = \frac{K_G}{1+sT_G} \quad (4)$$

$$T.F._{Sensor} = \frac{K_S}{1+sT_S} \quad (5)$$

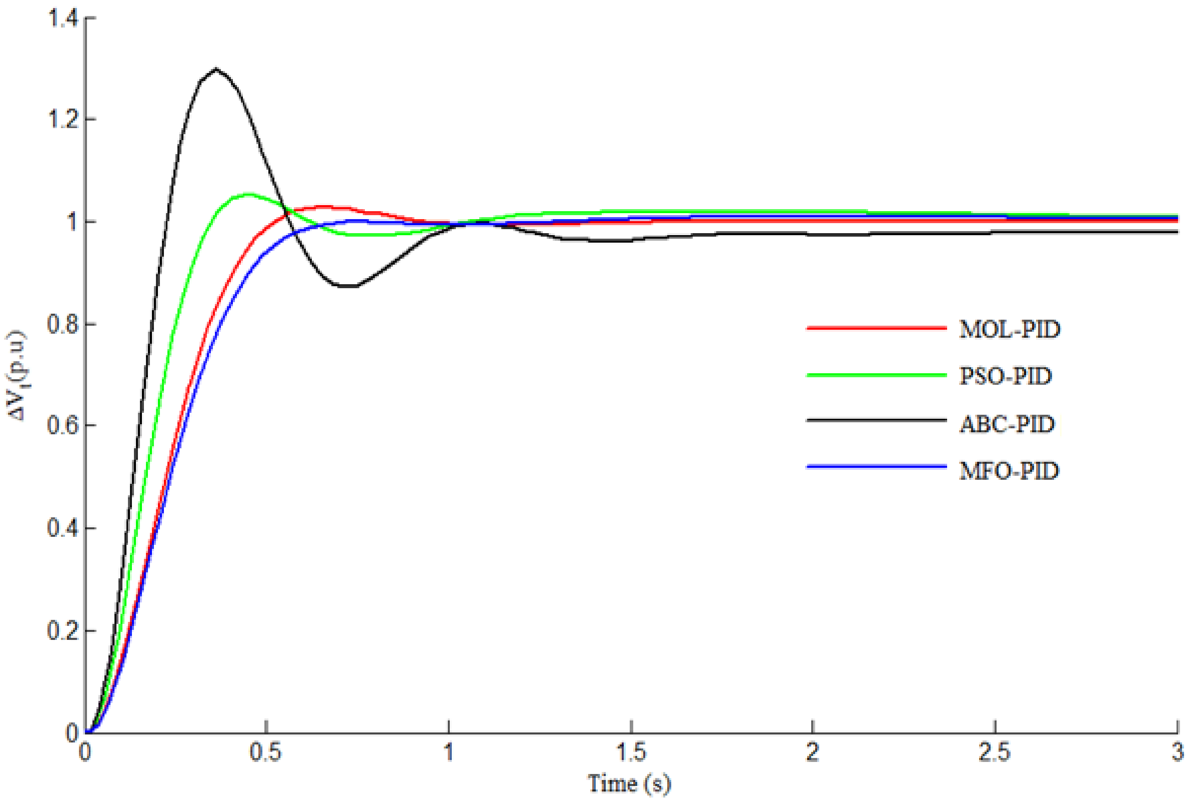


Fig. 2. Voltage response of AVR

DC Motor

The transfer function block diagram is shown in Fig. 3. In Fig. 4, the comparative response profile is shown.

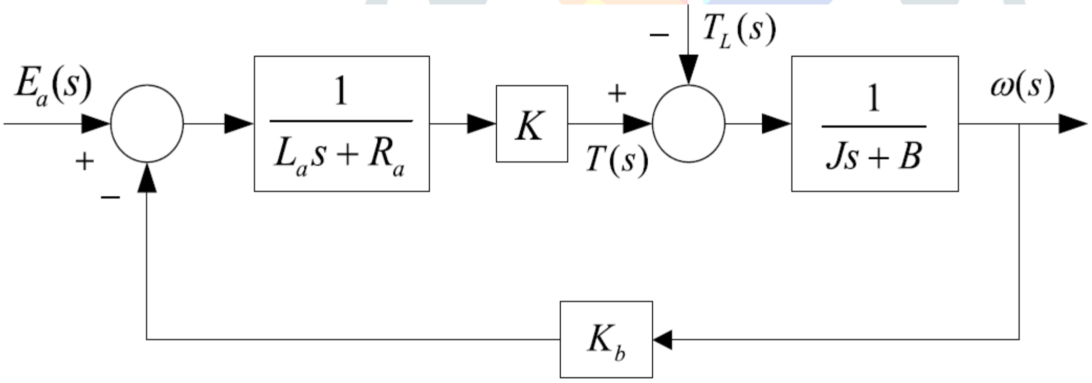


Fig. 3. DC Motor's Diagram

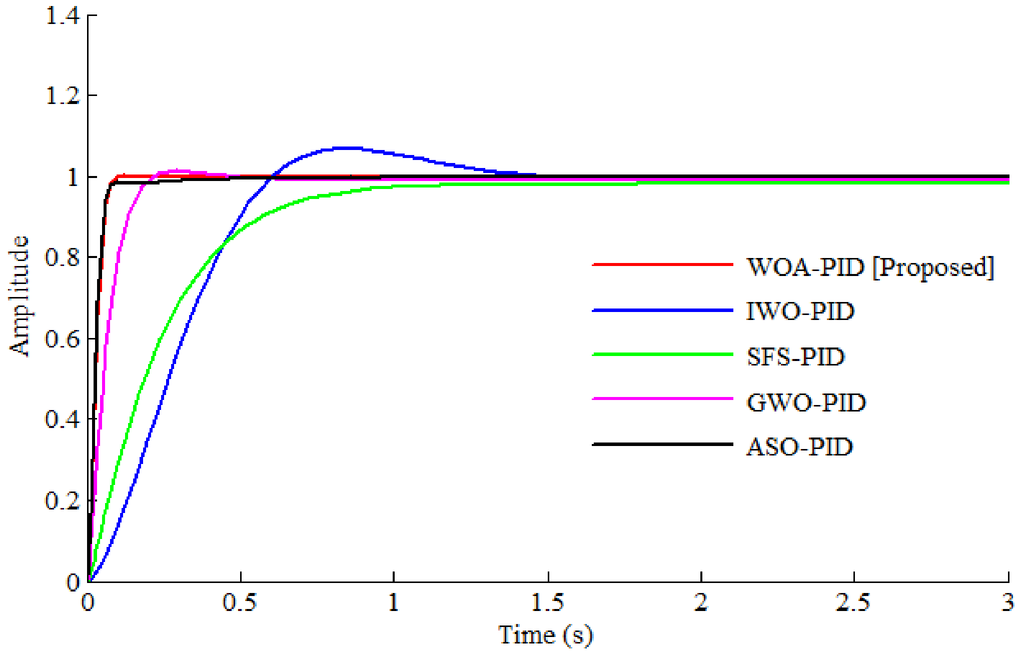
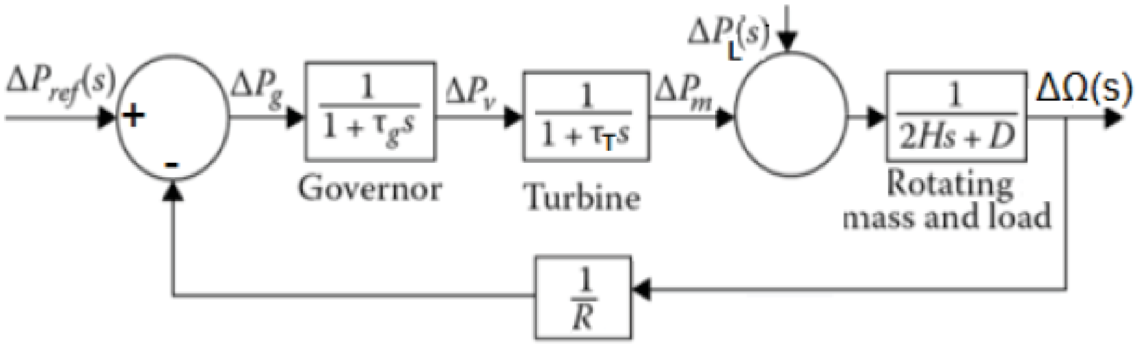


Fig. 4. Speed response profiles of DC Motor

ALFC

The transfer function block diagram of ALFC design has been portrayed in Fig. 5. The frequency profile is shown in Fig. 6.



Fig, 5. Transfer block diagram

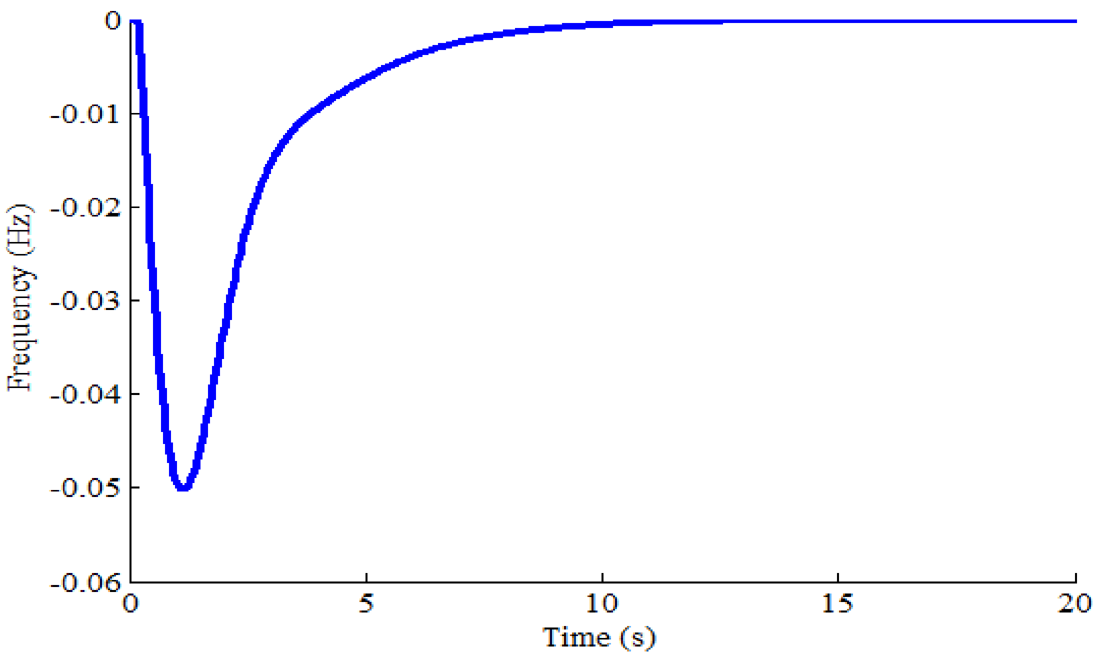


Fig. 6. Frequency response profile

From Fig. 2, Fig. 4 and Fig. 6, it may be observed that the soft computing techniques helps in obtaining desired parameters of PID controller for the considered power system applications.

Conclusion

In this review paper, the use of different soft computing techniques has been studied for tuning the parameters of the conventional proportional – integral – derivative controller which is employed for different power system applications.

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