

# Fractional Order PI Autotuning Method Applied to Multi-Agent System

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## 1 Introduction

In order to significantly improve operational efficiency, reduce costs and increase the degree of operational redundancy. Hence, multi-agent systems (MAS) are widely used in the construction of complex systems. Therefore, they are being widely recognized as new technologies for the next generation of distributed and intelligent industrial automation systems [1]. The distributed control systems approach is preferable for the development of applications that involve multiple autonomous units, which have to communicate with each other to achieve the common goal through their coordinated actions.

## 2 Control Strategies

A novel fractional order PI autotuner based on KC method [2] is applied to the multi-agent systems. This method consists in defining a forbidden region in the Nyquist plane based on user-defined specs, which will guarantee the system margin requirements. Its performance is compared with two other fractional order controllers based on PI gain-crossover autotuning method [3] and Internal Model Control (IMC) present in [4]. A numerical example considered is described by the following transfer function  $G(s)$  mimicking a part of a multi-agent flock:

$$G(s) = \begin{bmatrix} \frac{1.64}{50s+1} & \frac{2.49}{250s+1} \\ \frac{2.56}{75s+1} & \frac{1.28}{275s+1} \end{bmatrix}; \Lambda = \begin{bmatrix} -0.49 & 1.49 \\ 1.49 & -0.49 \end{bmatrix} \quad (1)$$

Checking input-output pairings, with a RGA (Relative Gain Array) analysis of the multivariable process. Its matrix  $\Lambda$  suggest that the pairing 1-2/2-1 is suitable, since the main diagonal has negative values

## 3 Results and Conclusions

According to results shown in Figure 1 and Figure 2, the KC method produces fractional order PI controllers that achieve excellent load disturbance rejection, while maintaining a good reference tracking performance. It is important to note

that the proposed method does not use the full knowledge of the system model. However, this shows that the KC method could obtain similar or better results than other controllers, which use the full knowledge of the system.

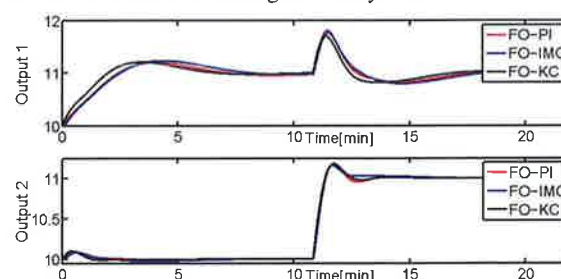


Figure 1: Comparative setpoint tracking test

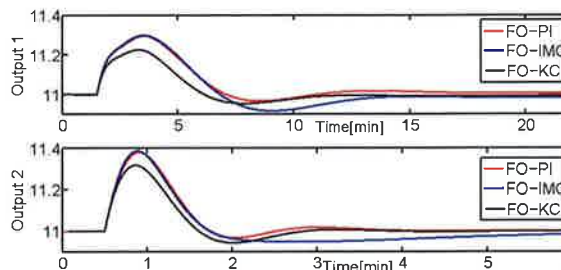


Figure 2: Comparative disturbance rejection test

## References

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