Editorial

Shaoyuan Li*

Department of Automation,
Shanghai Jiao Tong University,
800 Dongchuan Road,
Shanghai 200240, PR China
E-mail: syli@sjtu.edu.cn
*Corresponding author

Wen-Jian Cai

School of Electrical and Electronic Engineering,
Nanyang Technological University,
BLK S2, Nanyang Avenue,
Singapore 639798
E-mail: ewjcai@ntu.edu.sg

Biographical notes: Shaoyuan Li received his BS and MS from Hebei University of Technology in 1987 and 1992, respectively. He also received his PhD in Computer and System Science of Nankai University, China in 1997. Now he is a Professor and the Head of the Department of Automation, Shanghai Jiao Tong University. His research interest includes fuzzy systems, non-linear system control and so on.

Wen-Jian Cai received his BS and MS from Harbin Institute of Technology in 1980 and 1983, respectively. He also received his PhD in Systems Engineering, Oakland University, USA in 1992. Now he is an Associate Professor of School of Electrical and Electrical Engineering, Nanyang Technological University, Singapore. His research interest includes advanced process control, fuzzy logic control, robust control and estimation techniques and so on.

1 Introduction

Modelling and control technology are necessary parts in modern industry processes and play a critical role in improving the overall system performances. The purpose of modelling is to establish mathematical or logical relations for process behaviour, herein modelling process can be regarded as the fundamental part of the model-based advanced control system of industrial process including the process optimisation, monitoring and control. Theoretically, the modelling and control of a linear system are very mature and applied in an extensive way. However, as we know the industry processes are naturally non-linear and complex, the modelling and control problem to these complex systems poses a big challenge for control researchers and practitioners alike.

This Special Issue covers following subjects:

- identification and modelling techniques
- decentralised and decoupling control of multivariable systems
- predictive control and other advanced process control algorithms and
- case studies of process control.

2 Focus on this Special Issue

The paper by Amiya K. Jana presents the design of an inferential state estimator for process reaction in a batch distillation column. Batch distillation is one of the most important separation processes and is widely used in the fine chemical, biochemical, pharmaceutical and food industries. This separation unit has received renewed interest as the demand for low scale production with varying product purities has increased. In comparison to continuous distillation, batch distillation processes are more flexible and economically attractive because the same equipment can be used for several products and operating conditions. It is reported in this paper that faster convergence and more accurate estimates can be obtained by increasing the number of sensors and/or increasing the sampling frequency. It is also mentioned that above a certain number of sensors the improvement in the Extended Kalman Filter (EKF) performance may not be significant and may not justify the cost of adding more measurements. Although the EKF performed better than the Extended Luenberger Observer (ELO) at the expense of much larger computational load, when the EKF performance was severely affected by the location of measurement sensors. The goal of this

paper is to evaluate the applicability of a different observation approach for developing an inferential state estimator for a batch distillation column.

Model-based predictive control has been used in many control areas such as chemical and mechanical engineering during the past three decades, because it has a very intensive feature in view of performance. Two papers on advance predictive control are selected in this Special Issue. The paper by Su Bai-Li, Chen Zeng-Qiang and Yuan Zhu-Zhi discusses the constrained multivariable fuzzy generalised predictive control for non-linear systems, as most processes in industrial plants are inherently highly non-linear. For a highly non-linear system, a linear predictive control algorithm may not give rise to satisfactory dynamic performance. If a non-linear process can be precisely described by a set of linear subsystems in some way, the design of a predictive controller can be proposed for them and greatly simplified. Fuzzy models appear as an appealing modelling tool in the case of complicated non-linear systems, where conventional approaches failed or their application is too intricate. Among the fuzzy models, the T-S fuzzy model which was proposed by Takagi and Sugeno has been successfully applied to the control design of non-linear systems and it has been proved that the T-S fuzzy model is a universal approximator. In this paper, a simple constrained Generalised Predictive Control (GPC) algorithm is designed for a complicated non-linear system which is approached by a T-S fuzzy model. This algorithm can deal with non-linear and multivariable systems.

Another paper related to predictive control by Deng, Inoue, Yanou and Ishibashi is concerned with a design problem of a Multivariable Continuous-time Anti-windup Generalised Predictive Control (MCAGPC) using coprime factorisation and Youla-Kucera parameterisation for an aluminium plate thermal process with input constraints. A stability condition of a closed-loop system with input constraints was derived and a strongly stable feedback control system based on predictive control technique is therefore obtained. The effectiveness of the proposed MIMO method is coprimed through the simulation of applying the method to an aluminium plate thermal process.

Decentralised control is widely used for the control of multivariable plants. Prior to the design of the decentralised controllers, input-output pairing is an important step in the design procedure. In the face of unknown, uncertain or time varying plant parameters, the input-output selection may endure fundamental changes, which will severely degrade the decentralised controller performance. The paper by Moaveni and Khaki-Sedigh proposes a reconfigurable structure for the design of the decentralised controller based on the adaptive control strategies. The new methodology employed the Relative Gain Array (RGA) approach to input-output selection. It is shown that the adaptability property of the RGA methodology makes it appropriate for the reconfigurable framework to detect failure. The decentralised reconfigurable controller uses the Recursive Least Square (RLS) estimator to provide a real-time updated pairing based on input-output data. The structure of the decentralised controller can therefore be changed according to the online RGA identification. In this paper, an RLS estimator is used to provide an online estimate of the plant parameters and the RGA matrix, as shown in Section 2. The RGA matrix is analysed and if a new input-output pairing is required this information is passed to the control system design block. Based on the present input-output set, corresponding plant models are chosen and employing an adaptive output feedback pole-placement technique, the desired closed-loop performance is achieved. An actuator selection is made and the determined control signal is implemented through the appropriate actuator.

We believe that the ten papers presented in this Special Issue are representative of ‘Advanced Modelling and Control in Industry Processes’ and it is a fruitful area for interesting research and a lot of excellent contributions are being made.