



## Editorial

# Advances in Complex Control Systems Theory and Applications

Complex and large scale systems and networks have evolved in many fields: from communication data networks, banking, financial systems, bio-engineering and robotics to, amongst others, industrial control systems. In control engineering, the main driving force behind the expansion of large-scale complex systems has been the relatively low cost of installing advanced instrumentation hardware, the low cost of attaining high computing power and the desire to 'see' and 'monitor' as much of the process as possible.

Whereas previously a typical small scale manufacturing process would be controlled by a few dozen loops, this has now risen to thousands of loops complemented by extensive data logging facilities. Classical or even modern control systems design applications are reaching their practical limits in their abilities to analyse and study these complex systems. In particular, classical techniques generally lack the framework to handle large scale systems and/or lead to exceptionally poor performance, and modern methods have a tendency to completely disregard model complexity and general overtly complex control solutions.

At the same time, substantial increases in the cost of energy, raw material and labor has created an impetus for improved control of the systems. Numerous surveys have consistently shown that improved control will lead to more sustainable manufacturing, improved bottom line returns, efficiency gains and improved raw material yields.

Research in control of complex systems has received relatively little attention in recent years. This has been partly due to cheap cost of production and partly because study of model complexity evokes combinatorial optimisation problems which are extremely difficult to solve due to not having convenient mathematical features, such as, for example, convexity. Consequently, the overwhelming

majority of current industrial processes still run on a mixture of proportional integral (PI) and simple decentralised control systems implying that great amounts of resources remain un-utilised in these systems and networks. For example, in a typical industrial control system, the controllers might only be able to use as little as 5% of the information collected from the process for control purposes.

### Contributions

The call for papers for this special issue was warmly received by the control community. Fitting to the journal's title and scope, this selection of contributed papers by leading international researchers represents an excellent coverage of the field, including both theoretical and application papers. The set of 12 papers have been categorised into 4 areas as follows:

*Networked systems:* Many large complex systems nowadays are created by the networked connection of smaller subsystems. Control of networked systems is therefore a key topic in complex systems analysis and control. *Decentralised  $H_{\infty}$  quantiser design for uncertain interconnected networked systems* by Chen *et al.* deals with  $H_{\infty}$  controller design for uncertain interconnected systems using output feedback. In *Co-design of predictive controllers for wireless network control* by Irwin *et al.*, the network is assumed to be wireless and the authors propose predictive solutions to deal with the uncertain time delays. The final contribution in this category, *Network load minimisation design for dual-rate internet-based control systems* by Li *et al.*, deals with control of networked systems over the internet.

*Large scale systems:* Complex systems are synonymous with large scale systems. In this category, our first contribution is titled *Decentralised state feedback design for large-scale linear*

# Advances In Control Systems Theory Volume 8

**Guillaume Favre**



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