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A Bridge between Robustness and Simplicity: Practical Control Design for Complex Systems

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Summary: Automatic control design has been one of the major subjects in real-world system design/operation and is becoming much more significant today in accordance with increasing size, changing structure, uncertainties and complexity of artificial industry systems. A major challenge in a new environment is to integrate computing, communication and control into appropriate levels of real-world system operation and control.

In practice, many control systems usually track different control objectives such as stability, disturbance attenuation and reference tracking with considering practical constraints, simultaneously. At the moment in the industry applications, it is desirable to meet all specified goals using the controllers with simple structures. Since, practically these controllers are commonly designed based on experiences, classical and trial-and-error approaches, they are incapable of obtaining good dynamical performance to capture all design objectives and specifications for a wide range of operating conditions and various disturbances.

It is significant to note that because of using simple structure, pertaining to the low-order control synthesis for dynamical systems in the presence of strong constraints and tight objectives are few and restrictive. Under such conditions, the synthesis process may not approach to a strictly feasible solution. Therefore, the most of robust and optimal approaches suggest complex state-feedback or high-order dynamic controllers. Moreover in the most of proposed approaches, a single performance criterion has been used to evaluate the robustness of resulted control systems.

This research addresses three systematical, fast and flexible algorithms to design of low order or static output controllers for dynamical systems. The developed strategies attempt to invoke the strict conditions and bridge the gap between the power of optimal/robust control theory and industrial control design. To illustrate the effectiveness of the proposed control strategies, they have been applied to several complex systems in the electric industry.