The Third Generation of Control Systems

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In the modern era, the first generation of control systems was analog control. The platform for this was the operational amplifier. This platform needed an appropriate theory for its usage, which was developed by Nyquist, Evans, Bode, and others.

Around 1960, the second generation of control systems based on digital computing emerged, and this was a major change in the platform for control. It too required a new theoretical framework. This challenge was met by Kalman, Pontryagin and others, who developed a state-space based theory of control.

Much has changed since 1960. There have been tremendous advances in hardware, software and networking. This is causing yet another revolution in the platform for control, leading to a third generation of control systems.

This new platform too requires a strong and substantial research effort to take vision into reality. This research program can build on the activities from the 1960s onwards which laid the foundations of an ambitious system theory encompassing linear and nonlinear systems, stability theory, robust control, estimation, optimal control, decentralized control, adaptive control, identification, discrete-event systems, hybrid systems, etc.

The effort in the coming years can be more sharply focused since the technologies underpinning this next generation are now better understood or even already realized. There will need to be greater attention paid to the re-convergence of control with communication and computation. Also greater attention will need to be paid to the mechanism half of the policy-mechanism divide, since arguably much of the system theory developed in the last forty years was aimed at the policy half.

The twenty-first century could well be the era of large-scale system building, as we need to confront the twin issues of resource limitations as well as the desire to increase quality of life across the planet. The emergence of third generation control, which can play a central role in this era of system building, is thus a fortuitous development, and has come none too soon. It is an essential component of future smart grids, energy generation, storage and distribution systems, improved medical systems, zero-accident highways, green air transportation systems, water resources and environmental management, etc.

There has never been a brighter time for control systems.

References:

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