Mathematics of Control Across Disciplines

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Via Microsoft Teams

Abstract:

Control theory has developed many techniques borrowing tools from different branches of mathematics. Interestingly, many of the techniques conceived and routinely used to solve control problems can be quite successfully adapted to solve new relevant problems, both practical and curiosity-driven, in other fields.
In this talk we discuss how the analysis of systems can be very effective in explaining how mechanisms work, why they work in a certain way and to which extent they perform their task properly even in the presence of perturbations and disturbances.
The first part of the talk briefly introduces some preliminary motivating examples of mechanisms, borrowed from other disciplines alien to control theory, to show how a control approach can be very powerful to understand fundamental principles.
The second part introduces the definitions of structural versus robust properties, discussing paradigmatic case studies from the literature. These include a discussion about robust stability/instability analysis, presented in an inverse form: "We know this is stable, but why is it so incredibly stable?". Other fundamental concepts such as adaptation, oscillations, bistability and graph loop analysis are considered.
The third part discusses application examples from biology and biochemistry, to showcase the potential impact that the mathematical approach of control theory, suitably revised, can have in these disciplines and how interdisciplinary research can bring fresh ideas to control theorists.
The presentation will be informal with very few technical details (with very few exceptions): talking about math without math.