Control by Interconnection and Passivity–Based Control of Physical Systems

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As vividly illustrated by the quintessential Watt's governor a natural procedure to modify the behavior of a dynamical system is to interconnect it with another dynamical system. Examples of this approach abound in modern high–performance practical applications and are proven to be very robust and reliable. These include, among many others, mechanical suspension and flapper systems, flotation devices, damping windings and impedance matching filters in electrical systems.

Adopting the interconnection perspective allows us to formulate the control problem in terms of the physical properties of the systems like energy–shaping and damping injection, it furthermore underscores the role of interconnection to achieve these objectives. This should be contrasted with the classical actuator–plant–sensor paradigm that leads to a signal–processing view of control in which the systems physical properties are difficult to incorporate.

In this talk we propose a mathematical framework to design controllers using the aforementioned systems interconnection perspective that we call Control by Interconnection (CbI) [1]. In CbI the controller is another dynamical system connected to the plant (through a power–preserving interconnection) to add up their energy functions. Furthermore, we establish the connections between CbI and Standard PassivityBased Control (PBC). Standard PBC, where energy shaping is achieved via static state feedback, is one of the most successful controller design techniques. However, the control law is usually derived from an uninspiring and non–intuitive "passive output generation" viewpoint. We prove in this talk that Standard PBC, and in particular the well–known Interconnection and Damping Assignment control, are obtained restricting CbI to a suitable subset of the state space—providing a nice geometric interpretation to Standard PBC.

References

[1] R. Ortega, A. van der Schaft, F. Castaños and A. Astolfi, Control by state–modulated interconnection of port–hamiltonian systems, *IEEE Trans. Automat. Contr.*, , Vol. 53, No. 11, pp. 2527–2542, 2008.