Decoupling

Part I: An Open Problem 80 Years Old

Part II: An Original Solution

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This seminar is intended for the enthusiasts in linear systems and control.

A solution will be presented to the long-standing open problem of linear systems theory – diagonal decoupling by static state feedback. The earliest known investigation of system decoupling dates back to 1934, a state space formulation of the problem appeared in 1964, and a solution for square and invertible systems followed in 1967. The general case of right-invertible systems, however, has withstood all past efforts to obtain a solution.

Decoupling is a problem of compensating a given system in such a way that each system output can be independently controlled by a corresponding system input. The system is assumed to be linear, time-invariant, and giving rise to a proper rational transfer function matrix. Decoupling can always be achieved using dynamic compensation, which increases the order of the system. The static state feedback, however, does not increase the order and therefore may involve only the internal dynamics.

The mechanisms for the comprehension of the solvability of this very complex problem are presented for the very first time. The formulation avoids restrictive hypotheses concerning system and decoupling feedback. The existence of a solution is shown to depend on the existence of three lists of nonnegative integers conditioned by and only by system invariants with respect to the transformations permitted while decoupling. The solvability conditions are necessary and sufficient. The necessity proof is based on existence results whereas the sufficiency proof is based on constructive arguments and provides an algorithm to determine a decoupling feedback.

The seminar is divided in two parts. Part I includes an historical perspective, the problem formulation, and mathematical preliminaries. Part II includes a solvability condition, a synthesis of decoupling feedback, and illustrative examples. Part I is a prerequisite for Part II.

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Vladimír Kučera was born in Prague, Czech Republic in 1943. He graduated from the Czech Technical University in Prague and obtained his research degrees from the Czechoslovak Academy of Sciences.

Since 1967 he has been Researcher at the Institute of Information Theory and Automation, one of the research institutes of the Academy of Sciences of the Czech Republic. Since 1998 he has been a Professor of Control Engineering at the Czech Technical University in Prague. Currently he serves the university as Distinguished Researcher and Vice Director of the newly established Czech Institute of Informatics, Robotics, and Cybernetics. He held many visiting positions at prestigious European, American, Asian, and Australian universities. His research interests include linear systems and control theory. He contributed to the theory of Riccati equations and pioneered the use of polynomial equations in the synthesis of linear control systems. His best-known result is the parameterization of all controllers that stabilize a given plant, known as the Youla-Kučera parameterization, which has become a new paradigm in robust and optimal control.

Prof. Kučera is a Life Fellow of IEEE and an Advisor, Fellow, and a former President of IFAC. His awards include the National Prize of the Czech Republic in 1989 and the Automatica Prize Paper Award in 1990. He is an Honorary Professor of the Northeastern University, Shenyang, China, and received honorary doctorates from Université Paul Sabatier, Toulouse, France and Université Henri Poincaré, Nancy, France. In 2006, he was appointed Chevalier dans l'ordre des Palmes académiques by the French Government.