The minimal realization problem in physical coordinates

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The *minimal (state-space) realization problem* can be formulated as follows: "Given some input-output data $u(k), y(k)$, $k = 0, \ldots, N$, find a state-space description of minimal size n_x that is capable of reproducing the given data". The first algorithm for this problem has been developed by Ho and Kalman [1] in 1966, for single-input-single-output (SISO) state-space models. Nowadays, the solution algorithms for general multi-input-multi-output (MIMO) state-space models are the so-called "subspace methods" [2]. The minimal realization is not unique: given an invertible basis-change matrix T, the system transformed in the new coordinates $\tilde{x} = T^{-1}x$ maintains the same input-output behavior.

In this talk we deal with the minimal realization problem of systems described by physical-mathematical models; in these systems the state variables have a physical meaning. Then, we try to solve a harder problem: to find a minimal realization whose state vector is expressed in the *physical base*, that is true when each of its state variables has a twin variable in the physical-mathematical model describing the real system. We present the results from a novel approach [3].

Joint work with C. Faccio

References

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[2] P. Van Overschee and B. De Moor, *Subspace Methods in System Identification*, Springer, 1996.

[3] C. Faccio and F. Marcuzzi, *A linear algorithm for the minimal realization problem in physical coordinates with a non-invertible output matrix*, submitted to Linear Algebra and its Applications.