Decoupling Multivariate Functions in Block-oriented System Identification: A Linearization Approach

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Block-oriented non-linear system identification uses static non-linear multivariate functions to describe the non-linear effects in a system. The identification procedure usually results in a multiple input multiple output static mapping where in general a coupling exists between the variables (e.g., in the case of multivariate polynomials cross-terms between the input variables show up). For the sake of model interpretability, as well as to avoid the curse of dimensionality, it is desirable to find an equivalent parsimonious description where the non-linear functions are decoupled in a set of parallel single input single output mappings acting between some unknown internal variables (that are related to the inputs and outputs by means of unknown linear transformation matrices). We solve this decoupling task by means of a linearization approach: the first-order behavior of the multivariate functions is obtained in a set of operation points (this procedure is similar to constructing the small-signal model of a nonlinear element). The decoupling task then easily leads to a simultaneous matrix diagonalization problem from which the unknown linear transformations follow, as well as the internal univariate mappings.