

Tackling two drawbacks of polynomial nonlinear state-space models

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System identification aims at fitting a mathematical model to real-life observations of the world. For example, you might measure the sound of music in two places: directly (in the same room as the source) and from behind a wall. The sound behind the wall is then a muffled version of the original sound, with the high tones often more damped than the low tones. The relation between the two measurements can be described by a model and characterizes the acoustic behavior of the wall. This model can be used to simulate the sound behind the wall for other pieces of music or more general sounds. Models hence have the capability to predict new, unobserved real-life phenomena, what makes them very useful in engineering, but also in economics, in meteorology, etc.

Most of the phenomena or systems behave nonlinearly: a loudspeaker distorts the music, a robot arm has internal friction, ... Therefore, over the years, nonlinear models have gained more interest and nowadays, a wide variety of nonlinear models is studied. One such model, which has been successfully applied to several experimental setups, is the Polynomial Nonlinear State-Space (PNLSS) model. It is highly flexible, but some of its drawbacks need special attention. Dealing with those drawbacks is the subject of this thesis.

The first part presents an optimization method that is robust with respect to system and model instabilities. The second part reduces the complexity of the model by retrieving the underlying structure. With the methods in this thesis, it should be possible to deliver models that are better suited for the user.