# LCToolbox – A MATLAB toolbox for robust control design

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## 1 Introduction

The control engineering opportunities of robust linear controller synthesis based on $\mathscr{H}_\infty$ performance criteria have been thoroughly explored over the past decades. As a result, a mature theoretical understanding and efficient solution algorithms are available by now. Not only have promising (experimental) results appeared in literature, recent research has also shown that different classes of time-varying and nonlinear systems could be dealt with using a similar problem formulation. Nevertheless, these modern approaches seem not to get adopted by control engineers in industry.

Attempting to make the $\mathscr{H}_\infty$ paradigm more attractive, some software packages, both commercial and open-source, provide implementations of the required solution algorithms. A well-known example is the so-called Robust Control Toolbox that is integrated in The Mathworks' MATLAB. Although these tools are very useful for users who are familiar with the advanced mathematical background of modern controller synthesis, control engineers in industry are still left with tedious pre- and postprocessing steps. Furthermore, linear parameter-varying (LPV) models currently only have limited support, while the design procedure is almost identical (for the end user). Some effort has already been made to develop a bridging interface that makes the design procedure more intuitive, unifies the syntax for different algorithms, and shields the user from pre- and postprocessing as much as possible [1].

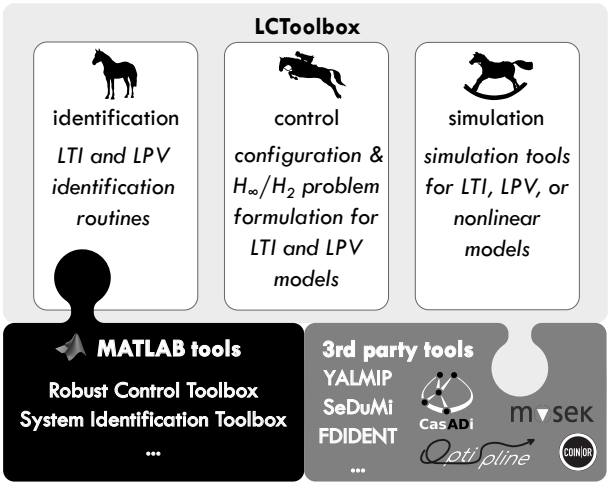


**Figure 1:** Conceptual overview of the capabilities of LCToolbox and its interface to existing software packages.

In this work, we present 'LCToolbox', a linear control toolbox for MATLAB, which is based on the work presented at the 36th Benelux Meeting on Systems and Control [2]. In addition to facilitating the issues mentioned earlier, this new toolbox version also aims at supporting the control engineer throughout the entire design procedure from identification up to verification of the results. This is conceptually illustrated in Figure 1 and will be presented through a mechatronic case study. The support for LPV models has been further improved as well.

## 2 Features of LCToolbox

### 2.1 Identification

Since an accurate model is required for $\mathscr{H}_\infty$ controller synthesis to reach its full potential, the linear control toolbox interfaces several algorithms helping the user to obtain an LTI or LPV model with the desired accuracy. At this point, the software mainly focuses on frequency domain identification methods. Apart from a model, these methods usually also allow to estimate the uncertainty on the model, which can be exploited in the robust control problem formulation.

### 2.2 Controller design

In order to define the control topology, the user can simply define signals, connect systems to each other and define performance channels as an input-output relation between signals. The control problem formulation is then easily formulated as a set of objectives and constraints on these (weighted) channels. The toolbox constructs the generalized plant and automatically selects an appropriate (third-party) solver for the problem.

### 2.3 Simulation

The toolbox environment also supports the user to close a feedback loop with, for example, a nonlinear model or a linear nonparametric (measured) model. As such, it is possible to verify the performance of the controller both in the time domain and in the frequency domain with a more accurate model than the design model.

## References

[1] M. Verbandt, J. Swevers, and G. Pipeleers. "An LTI control toolbox – Simplifying optimal feedback controller design." European Control Conference (ECC) 2016, June 2016, Aalborg, Denmark.

[2] M. Verbandt, J. Swevers, and G. Pipeleers. "A Linear Control Toolbox - towards simple LPV control." 36th Benelux Meeting on Systems and Control, March 2017, Spa, Belgium.

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