Iterative Formulation of Control Aims in Fully Probabilistic Design

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A control design converts knowledge about the controlled system, constraints and control aims into the controller. Control aims must be quantified in the way compatible to the design. A systematic quantification of the control aims, called aim elicitation, is the least supported step of the design process. We present a solution of this problem within the framework of a fully probabilistic design (FPD) [1].

Any controller modifies the closed-loop behaviour to reach the control aims. The controller is chosen in order to minimize a given loss function. The FPD selects the controller that minimizes the Kullback-Leibler divergence of the joint probability density function (pdf) describing closed-loop behaviour to the ideal pdf. The ideal pdf expresses both the desired closed-loop behaviour and constraints on system inputs. Thus within the FPD, the aim elicitation reduces to the choice of the ideal pdf.

For complex multidimensional systems, the task to construct the ideal pdf may represent a nontrivial problem requiring an expert experienced both in practical treatment of the system and theory as well.

The poster proposes a conservative construction of the ideal pdf. Similarly as the popular "windsurfer" approach to control design [2], it iteratively modifies intermediate control aims according to gradually learnt model of the observed closed loop. The proposed methodology is applied to normal pdfs. In this case, the FPD algorithmically coincides with linear-quadratic control design. Thus, the methodology simplifies use of this practically important control design and exploits better its potential. This statement is illustrated by numerical examples.

References

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