LeCoPro - Learning Control for Production Machines: More than Iterative Learning Control?

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1 Introduction

Learning control methods can contribute to enhance the efficiency and flexibility in the machine building industry as they allow machines to automatically learn the optimal control parameters and adapt to variations in both process parameters and environmental conditions. The LeCoPro project intends to create a knowledge platform in Flanders on learning control strategies for production machines. The consortium consists of FMTC, VUB (ELEC-COMO), UGent (SYSTeMS) and KULeuven (PMA-SCD-MeBioS). Two related research tracks are acknowledged: (i) learning control methodologies for complex (sub)systems and (ii) learning control methodologies for decentralized systems.

2 Subsystem learning control

The most popular learning techniques for the control of mechatronic subsystems are Iterative Learning Control (ILC) and Model Predictive Control (MPC). Although many successful implementations of ILC and MPC have been realized, these techniques can not be applied in certain situations e.g. when it is impossible to derive a model of the controlled system, when no reference signal is available, etc. To increase the applicability of learning algorithms to a broader range of mechatronic applications, the extension of the existing model-based strategies (ILC [1] and MPC [2]) as well as the application of non-model based machine learning techniques (Evolution-based Machine Learning (EBML [3]) and Reinforcement Learning (RL [4])) on mechatronic subsystems is studied in LeCoPro.

3 Global learning control

In most of the current mechatronic applications with multiple subsystems, a controller is developed for each subsystem. However, the interactions between these different individual controllers are not taken into account in the control design. Such a strategy often leads to a suboptimal global performance of the control system, especially for strongly interacting subsystems. Therefore, the possibilities of model-based (fuzzy MPC) as well as non-model-based (EBML and RL) global learning controllers are investigated to coordinate interconnected subsystems.

4 Development cases

For the practical validation of the different learning control techniques, some development cases have been selected: the control of wet clutches in a transmission, the control of a tractor with an implement and the control of the motors in a badminton robot. The performance of the learning controllers is compared with the performance of current machine controllers to check the strengths and weaknesses of the different learning controllers.

Figure 1: The development cases in LeCoPro

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References