

Developments in theory and practical applications of Iterative Learning Control (ILC), repetitive processes and multidimensional (nD) systems

The basic feature of multidimensional (nD) systems is that they transmit information in many independent directions. Hence, every system variable, i.e. inputs, outputs and states are multivariate (vector) functions of discrete and/or continuous indeterminates and the system dynamics evolves over all of them. These systems are very similar to spatially distributed systems which are described by partial differential or difference equations (PDE).

One of the particular cases of nD systems are the so-called repetitive processes (RP) where one indeterminate counts executions, runs, iterations, trials or passes of some operation, and the remaining indeterminate, for temporal and/or spatial character are continuous or discrete. The first indeterminate is unbounded, when the second is finite. Hence, a dynamics of repetitive process evolve over the strip on the plane, or e.g. more dimensional regular figure. For extended systems with spatio-temporal dynamics, the executed operations can be described by more than one indeterminate but also within the regular, closed area, as e.g. a rectangle, a disc, a cuboid or a ball.

Repetitive processes have many physical or industrial applications where some operations are cyclic as for a motor, a gantry robot or a robotic manipulator and many others. They can be used also for modeling various processes and objects.

One of applications of RPs is Iterative Learning Control (ILC), where the fundamental idea is to use available information from both, the previous and the current trials, to improve the tracking performance successively from trial to trial. Hence, there exists the possibility to create, analyze and design successfully ILC schemes in terms of repetitive processes. ILC is a very promising technique, which can lead to very interesting theoretical and application results. Recently it finds a great interest in research but in industry is not exploited sufficiently yet. One of the aims of this research project is to extend possibilities of further industrial applications of ILC, to as e.g. to a magnetic levitation test rig, a two-disk oscillator with flexible shaft, industrial machines that contain flexible components that deform under the influence of the force, magnetic bearings. There is planned also to develop ILC algorithms for switchable systems.

Finally, the problem of equivalence of classes of 2(n)-D systems, such as iterative learning control systems versus the Roesser and the Fornasini-Marchesini state space models, by using the polynomial system matrix approach will be studied. One of the main goals here is the model dimension reduction.