Optimizing Design Choices in Repetitive Control Systems for Convergence Robustness

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Abstract: Repetitive control iterates in real time with feedback control system data, aiming to converge to zero tracking error of a feedback control system following a periodic command or in the presence of a periodic disturbance of known period. The objective of convergence to zero tracking error in hardware instead of convergence to zero error in a mathematical model of the hardware means that it is possible to obtain much higher tracking accuracy. But convergence to zero error depends on how much and in what way the hardware behavior deviates from the anticipated model. The lower limit on the potential tracking error in hardware is determined by the reproducibility level of the hardware when repeatedly performing a commanded trajectory.

In the development of the repetitive control law, there are various design choices to make. This paper gives an overall picture of the influence of the design choices on robustness of the convergence to zero error. Five issues are addressed: (1) Optimization or adjustment of the digital control sample rate, upper limit of the frequency in the cost function, the choice of cutoff frequency, and the feedback gain size penalty in the cost function. (2) Introducing an overall repetitive control gain that reduces the convergence rate. (3) Relaxing the requirement for zero tracking error for some frequency range to produce convergence robustness. And (4) methods to produce robotustness to fluctuation of the disturbance period when this is an important issue to address. Producing robustness of this kind is normally in competition to methods that improve robustness to other types of model error. The resulting understanding obtained can be used to improve performance of repetitive control systems.

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