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Iterative Learning –Deep Dive

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The stability and convergence of an Iterative Learning Controller (ILC) may be assessed in time domain, by actually iterating the equations for a variety of inputs, or by finding the eigenvalues (lambda) of the iterated system (lambda-domain), or by forming the Z-transform and applying analogues of the Nyquist criteria. Two often-used criteria are (i) Asymptotic Convergence (AC) of the difference vectors, and (ii) monotonic convergence (MC) of the vector norm. Both criteria have lambda and Z domain counterparts. In this paper we apply all three methods and both convergence tests to a simple plant, namely an RF cavity oscillator with proportional and integral control, with an ILC wrapper to reject a periodic beam-loading disturbance. One, two and three-term (causal and acausal) learning function are used. Simplicity of the system means all convergence tests can be applied analytically. We can then ask the questions: do all the tests work, and do they agree on the stability? For this particular system, the Z-domain AC test agrees with the lambda-domain MC test. Moreover, soliton solutions appear in time domain for gain parameters constrained only by the AC test in lambda-domain.

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