Experience Using SQP Methods to Design Iterative Learning Controllers

R. W. Longman[1] **and F. Gao**[2]

Abstract: When feedback control systems are given a commanded desired trajectory to perform, they always produce a somewhat different trajectory. For example, frequency response plots of the command to output normally indicate that high frequency components of the command will get attenuated and phase lagged. This means that feedback control systems make repeating deterministic errors in responding to time varying commands.

Iterative learning control (ILC) is a relatively new field within control that aims to converge to zero tracking error executing a specific trajectory. ILC iteratively adjusts the command given the control system, aiming to converge to that command which produces the desired output. An important aspect of this process is that because it is iterating with the real world behavior instead of iterating with a mathematical model, it is possible to converge to zero tracking error in spite of inaccuracies in the model used for ILC design.

When the desired output is a feasible trajectory, it is still possible that during the ILC iterations, inequality constraints on the actuators will be violated by the command in some iteration, and this makes most ILC algorithms diverge. This issue is complicated by the fact that actuator limits occur inside the control loop, not on the input. This paper studies the use of quadratic cost ILC control laws making use of QP methods that allow us to impose inequality constraints on actuators. This approach to ILC is studied for it effectiveness in eliminating divergence. Of particular interest is the examination of the influence of model inaccuracy in the constraint inequalities. Approaches are suggested to robustify the QP iterations to model error.

[1] Department of Mechanical Engineering
Columbia University MC4703
500 West 120^{th} Street, New York, NY 10027, USA
rwl4@columbia.edu

[2] Department of Mechanical Engineering
Columbia University MC4703
500 West 120^{th} Street, New York, NY 10027, USA
Also, Tsinghua University, Beijing, China
gaofei07@mails.tsinghua.edu.cn