

Digital Signal Processing via Sampled-Data Control Theory

Yutaka Yamamoto

Department of Applied Analysis
and Complex Dynamical Systems
Graduate School of Informatics

Kyoto University

Kyoto 606-8501, Japan

yy@i.kyoto-u.ac.jp

<http://www-ics.acs.i.kyoto-u.ac.jp/~yy/>

There has been remarkable progress in sampled-data control theory in the last decade. The main accomplishment here is that there exists a digital (discrete-time) control law that takes the intersample behavior into account and makes the overall analog (continuous-time) performance optimal, in the sense of H^∞ -norm. The same hybrid nature of designing a digital filter for analog signals is also prevalent in digital signal processing. A crucial observation is that the perfectly band-limited hypothesis, widely accepted in the signal processing literature, is often inadequate for many practical situations. In practice, the original analog signals (sounds, images, etc.) are neither fully band-limited nor even close to be band-limited in the current processing standards. This is the problem of interpolating high-frequency components, which in turn is that of recovering the intersample behavior. Sampled-data control theory provides an optimal platform for such problems.

This talk starts by reviewing some background in system theory, show that how certain ideas in sampled-data control have roots in early system theory, and then points out the problem in the theory in the pure discrete-time domain. We then proceed to review certain aspects of digital signal processing, provide a new problem formulation, and a new design procedure, which does not rely on the perfect band-limiting hypothesis. We give various applications in sound processing/compression and image processing.

Related information may be found in my web site:

<http://www-ics.acs.i.kyoto-u.ac.jp/~yy/>, and particularly under the links:

<http://www-ics.acs.i.kyoto-u.ac.jp/~yy/sound.html>

<http://www-ics.acs.i.kyoto-u.ac.jp/~yy/image.html>