From Sampled-data Control to Signal Processing – Beyond the Shannon Paradigm

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Biography:

Yutaka Yamamoto received his B. S. and M. S. degrees in engineering from Kyoto University, Kyoto, Japan in 1972 and 1974, respectively, and the M. S. and Ph. D. degree in mathematics from the University of Florida, in 1976 and 1978, respectively. From 1978 to 1987 he was with Department of Applied Mathematics and Physics, Kyoto University. In 1987 he joined the Department of Applied Systems Science as an Associate Professor, and became a professor in 1997. He is currently a professor at the Department of Applied Analysis and Complex Dynamical Systems, Graduate School of Informatics of Kyoto University. His research and teaching interests are in realization and robust control of distributed parameter systems, learning control systems, and sampled-data systems, its application to digital signal processing, with emphasis on sound and image processing. Dr. Yamamoto received Sawaragi memorial paper award in 1985, outstanding paper award of SICE in 1987 and in 1997, the best author award of SICE in 1990 and in 2000, the George S. Axelby Outstanding Paper Award in 1996, and the Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology Prizes for Science of Technology in 2007. He received IEEE Control Systems Society Distinguished Member Award, and also ISCIE Best Industrial Paper Award in 2009. He is a Fellow of IEEE and SICE. He was an associate editor of the IEEE Transactions on Automatic Control, Automatica, Systems and Control Letters, and is currently an associate editor of and Mathematics of Control, Signals and Systems. Since 2010, he has been acting as a Senior Editor for the IEEE Transactions on Automatic Control. He also served as an organizing committee member of 35th CDC in 1996, MTNS '91 in Kobe, and as a member of program committees of several CDC's. He was the chair of the Steering Committee of MTNS, served as General Chair of MTNS 2006. He was vice President of CSS of IEEE for 2005-2008. He was a past President of ISCIE of Japan.

Abstract:

There has been remarkable progress in sampled-data control theory in the last two decades. The main achievement 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-infinity norm. This naturally suggests its application to digital signal processing where the same hybrid nature of analog and digital is always prevalent. A crucial observation here is that the perfect band-limiting hypothesis, widely accepted in signal processing, 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. The problem is to interpolate high-frequency components beyond the so-called Nyquist frequency, and this is nothing but the intersample signals discarded through sampling. Assuming a natural signal generator model, sampled-data control theory provides an optimal platform for such problems. This new method has been implemented to a custom LSI chips by SANYO corporation, and has made success of producing over 16 million chips. This talk provides a new problem formulation, design procedure, and various applications in sound processing/compression and image processing.