Abstract

First-order and second-order digital filters are the fundamental building blocks of the cascade and parallel realizations of many digital filters. These digital filters are commonly implemented in hardware using a two’s complement arithmetic for the addition operation. Because of the adder overflow nonlinearity, the physically realized digital filter is actually a nonlinear discrete system. This system has rich dynamics that it may exhibit chaotic behaviors.

In the seminar, the dynamics of such a system is discussed. Given any fixed filter parameters inside different regions of the parameter space, the responses of the filter will give different types of trajectories of the state vector, depending on the values of the initial conditions.

Besides, a more practical digital filter of finite word length is discussed. Theoretically, if a digital filter exhibits chaotic behavior in their trajectories, the trajectories should have an infinite number of states. However, a digital filter of finite word length is actually a finite state machine. Nevertheless, some simulation results are shown in the seminar that a finite state machine may exhibit near-chaotic behaviors in their trajectories, even the corresponding infinite state machine does not suffer from overflow.

About the Speaker

Peter Tam was born and educated initially in Hong Kong. In 1967, he went to Newcastle in Australia, to receive industrial training and further education there. In 1971, he graduated B.E. in electrical engineering with first class honors from the University of Newcastle. From the same university, he received the M.E. and Ph.D. degrees in 1973 and 1976, respectively. From 1967 to 1980, he held a number of industrial and academic positions in Australia. In 1980, he joined the Hong Kong Polytechnic as a Senior Lecturer. He is currently an Associate Professor in the Department of Electronic and Information Engineering of The Hong Kong Polytechnic University. His research interests include signal processing, control theory, fuzzy systems, and artificial neural networks.