Invited Overview Session

Session: SP1-1.1
Time: Saturday, December 19, 14:00 - 14:30
Place: Room Y301
Chair: Jay C.C. Kuo, University of Southern California (U.S.A.)

Sparse Adaptive Filters -an Overview and Some Emerging Trends

Speaker: Mrityunjoy Chakraborty, Indian Institute of Technology, Kharagpur, India

Abstract
In practice, one often encounters systems that have a sparse impulse response (IR), with the degree of sparseness varying over time. Examples of such systems include network echo channels in voice and data communication, wireless multipath channels in mobile communication, echo channels in HDTV, acoustic channels in underwater communication etc. The a priori information about sparseness of the system IR, if exploited properly, can significantly improve the identification performance of the algorithm deployed to identify it. In recent years, several sparse adaptive filters have been proposed that cleverly incorporate the a priori knowledge about sparseness of the system in the coefficient adaptation relations and thus perform better. The first and foremost in this category is the proportionate normalized LMS (PNLMS) algorithm and its variants like the improved PNLMS (IPNLMS) and the ?-law PNLMS (MPNLMS). In the PNLMS category of algorithms, the step size for each coefficient is made proportional to the magnitude of the corresponding coefficient update, thereby making it large for active taps (leading to faster rate of convergence initially) and small for inactive taps (leading to lesser steady state excess mean square error (EMSE)). Apart from the PNLMS family, another powerful class of sparse adaptive filters has come up in recent years, inspired by the recent advent of compressive sensing in general and LASSO in particular. The primary development in this is the so-called zero attracting LMS (ZA-LMS) algorithm, obtained by adding a norm penalty (of the filter coefficient vector) to the LMS cost function. Minimization of the cost function introduces certain zero attractors in the weight update formula which pull the coefficient updates towards zero. The ZA-LMS was later modified to reweighted zero attracting LMS (RZA-LMS) where the shrinkage is restricted only to the inactive taps. The ZA-LMS and the RZA-LMS algorithms offer lesser steady state EMSE as compared to the PNLMS family while enjoying a convergence rate that is reasonably good though not as high as that of the PNLMS. In addition to the PNLMS family and the ZA-based algorithms, there have been several other approaches also to realize a sparse adaptive filter, notably, the partial update LMS, convex combination of adaptive filters etc. Further, sparse adaptive filters have been used as nodes in a distributed network deployed to identify the unknown sparse system and diffusion strategies have been devised for sharing of information within the neighborhood of each node,, resulting in refined estimates.

The purpose of this talk is to present the basics of some of the major recent developments in the context of sparse adaptive filters. No background knowledge in this area will be assumed though some familiarity with basic adaptive filtering will be helpful. It is expected that participants will gain some useful input from this talk, enabling them to pursue further studies in this area in future.

Biography

Mrityunjoy Chakraborty obtained Bachelor of Engg. from Jadavpur university, Calcutta, Master of Technology from IIT, Kanpur and Ph.D. from IIT, Delhi. He joined IIT, Kharagpur as a faculty member in 1994, where he currently holds the position of a professor in Electronics and Electrical Communication Engg. The teaching and research interests of Prof. Chakraborty are in Digital and Adaptive Signal Processing, VLSI Signal Processing, Linear Algebra and Compressive Sensing. In these areas, Prof. Chakraborty has supervised several graduate theses, carried out independent research and has several well cited publications.

Prof. Chakraborty has been an Associate Editor of the IEEE Transactions on Circuits and Systems, part I (2004-2007, 2010-2012) and part II (2008-2009), apart from being an elected member (also currently the chair elect) of the DSP Technical Committee (TC) of the IEEE Circuits and Systems Society, a guest editor of the EURASIP JASP (special issue), track co-chair (DSP track) of ISCAS 2015 & 2016, Gabor track chair of DSP-15, and a TPC member of ISCAS (2011-2014), ICC (2007-2011) and Globecom (2008-2011). Prof. Chakraborty is a co-founder of the Asia Pacific Signal and Information Processing Association (APSIPA), is currently a member of the APSIPA BOG and also, served as the chair of the APSIPA TC on Signal and Information Processing Theory and Methods (SIPTM). He has also been the general chair and also the TPC chair of the National Conference on Communications - 2012.

Prof. Chakraborty is a fellow of the Indian National Academy of Engineering (INAE) and also a fellow of the IETE. During 2012-2013, he was selected as a distinguished lecturer of the APSIPA.